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ROLLO'S EXPERIMENTS.

BY THE

AUTHOR OF ROLLO LEARNING TO TALK, TO
READ, AT WORK, AT PLAY, AT SCHOOL,
AT VACATION, &c.

PHILADELPHIA:
PUBLISHED BY HOGAN & THOMPSON.
AND
BOSTON:
BY GOULD, KENDALL & LINCOLN.
1845.

Entered according to Act of Congress, in the year 1839,

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CONTENTS

	Page
JONAS AN ASTRONOMER	23
PRUNING	23
THE GREAT BEETLE AND WEDGE.....	35
THE LITTLE BEETLE AND WEDGE.....	46
SPLITTING	59
HOROLOGY.....	80
JONAS'S DIAL.....	94
THE BEE-HIVE.....	112
JONAS'S MAGNET	124
MAGNETISM.....	139
INTELLECTUAL PHILOSOPHY	157
OSCILLATIONS	165

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ROLLO'S EXPERIMENTS.

JONAS AN ASTRONOMER.

ONE day, when Rollo was about seven years old; he was sitting upon the steps of the door, and he heard a noise in the street, as of some sort of carriage approaching. A moment afterwards, a carryall came in sight. It drove up to the front gate, and stopped. Rollo's father and mother and his little brother Nathan got out. His father fastened the horse to the post, and came in.

When Rollo first heard the noise of the carryall, he was sitting still upon the steps of the door, thinking. He was thinking of something that Jonas, his father's hired boy, had told him about the sun's shining in at the barn door. There was a very large double door to Rollo's father's barn, and as this door opened towards the south, the sun

used to shine in very warm, upon the barn floor, in the middle of the day.

Rollo and Jonas had been sitting there husking some corn,—for it was in the fall of the year;—and as it was rather a cool autumnal day, Rollo said it was lucky that the sun shone in, for it kept them warm.

“Yes,” said Jonas; “and what is remarkable, it always shines in farther in the winter than it does in the summer.”

“Does it?” said Rollo.

“Yes,” said Jonas.

“And what is the reason?” asked Rollo.

“I don’t know,” said Jonas, “unless it is because we want it in the barn more in the winter than we do in the summer.”

“Ho!” said Rollo; “I don’t believe that is the reason.”

“Why not?” said Jonas.

“O, I don’t believe the sun moves about in the heavens, to different places, only just to shine into barn doors.”

“Why, it keeps a great many farmers’ boys more comfortable,” said Jonas.

“Is it so in all barns?” asked Rollo.

“I suppose so,” said Jonas.

After some further conversation on the

subject, the boys determined to watch the reflection of the sun's beams upon the barn floor for a good many days, and to mark the place that it came in to, at noon every day, with a piece of chalk. It was only a few minutes before the carryall came up, that they had determined upon this, and had marked the place for that day; and then Rollo had come out of the barn, and was sitting upon the door step, thinking of the subject, when his reflections were interrupted in the manner already described.

So, when Rollo saw his father getting out of the carryall, he ran to meet him, and called out to him, talking very loud and rapidly,

"Father, Jonas says that the sun shines farther in, upon the barn floor, in winter than in summer;—does it, do you think?"

But this was not a proper time for Rollo to bring up his philosophical question. His father had a carpet bag and several packages in his hands, and he was also conducting Rollo's mother in, and thinking about the horse and carryall. So he told Rollo that he must not speak to him then, for he could not attend to him.

Rollo then walked along back into the yard, and began to think of the subject of the sun's shining in at the south door. He looked up towards the sun, and began to consider what sort of a change in its place, at noon, on different days, would be necessary in order to account for its shining in more at south doors and windows, on some days, than on others. He reflected that if the sun were exactly overhead, at noon, it could not shine in at any doors at all ; for the rays would then strike perpendicularly down the sides of the houses. While he was standing thus, lost in thought, looking up to the sun, with his arm across his forehead, to shelter his eyes a little from the dazzling rays, he suddenly felt the pressure of two soft hands upon his ears, as of somebody who had come up behind him. He turned round, and found his cousin Lucy standing there.

Lucy asked him what he was thinking of, and he told her. He then took Lucy into the barn, and showed her the chalk mark upon the floor. She looked on with a good of interest, and said she thought it was an excellent plan ; and she wished there was a

great barn with a south door at *their* house. Lucy knew more about the subject than Rollo did, and she gave him some explanations about it. "You see," said she, "that the sun rises in the east every morning, and comes up higher and higher, every hour, till noon ; and then it begins to go down again, and at last it sets in the west. But, at some times in the year, it comes up higher at noon than it does at other times, and so it does not shine so much into the door."

"It shines *more*, you mean," said Rollo.

"No," said Lucy ; "not so much. In the winter the sun moves around by the south, and keeps pretty low all day, and of course shines farther into doors and windows."

Then, after a moment's pause, she added,

"If we should mark the place on the floor all the year round, we should find what time the sun is farthest to the south."

"So we should," said Rollo.

"It would be in the winter," said Lucy.

"Yes," said Rollo ; "in the middle of the winter exactly."

"Yes," said Lucy ; "and in the middle of the summer it would be nearest overhead."

"Jonas and I will try it," said Rollo.

"I can try it in the house," said Lucy
"where the sun shines in at my chamber
window."

"O no," said Rollo; "that won't do."

"Why not?" said Lucy.

"Because the window does not come
down to the floor, and so does not let the
sun in enough."

"O, that makes no difference," said
Lucy; "we have nothing to do with the
bottom of the door; you only mark where it
shines in the farthest, and that place is made
by the top of the door, for it shines in far-
thest by the top of the door."

"Well," said Rollo, "I don't know but
that the house will do; but then you can't
chalk on the carpet."

"Chalk on the carpet?" said Lucy.

"Yes, to mark the place."

"No," said Lucy, thinking; "but I can
mark it some other way."

"How?" asked Rollo.

"Why, I can put a pin in," said Lucy.

"O dear," said Rollo, with a laugh, "put
a pin in! That's no way to mark a
shadow."

"It isn't a shadow," said Lucy.

"Yes, it is," said Rollo.

"No," said Lucy; "a shadow is dark, and this is bright."

"Yes," said Rollo, "this is a bright shadow; some shadows are bright, and some are dark."

"O Rollo!" said Lucy; and she turned away from him, a little out of humor.

The truth was, that Rollo and Lucy were getting decidedly into a dispute. From the sublime heights of practical astronomy, they had fallen, by a sad and very rapid descent, to a childish altercation. Rollo had a very high idea of the superior facilities afforded by Jonas's barn floor for observing the daily changes in the sun's meridian altitude, and he did not like the idea of Lucy's finding that she had equally good opportunities for observation at her home. Lucy was a little fretted at Rollo's captious spirit; but then her mind soon became unruffled again, and she turned back towards Rollo, and said, as they walked along the yard,

"I don't think the sunshine on the floor is a shadow, Rollo; but then I don't see why a shadow would not do, just as well."

"How?" said Rollo.

"Why, look there at the shadow of that post,—that would do."

She pointed to a post with a rounded top upon it, which stood by the side of the garden gate. The shadow, clear, distinct, and well defined, was projected upon the walk; and Lucy told Rollo that they might mark the place where the top of that shadow came every day, and that that would do just as well.

"But how could we mark it?" said Rollo.

"Why, we could drive a little stake unto the ground."

"O, that would not do," said Rollo. "People would trip over them, and break them down. They would be exactly in the walk."

Lucy saw that this would be a difficulty, and, for a moment, seemed to be at a loss. At length, she said,

"We might go somewhere else, then, where the people would not come."

"But what should we do for a post?" said Rollo.

"Could not we get Jonas to drive a tall stake down?" said Lucy.

"Yes," said Rollo; "I suppose so."

The children went out into the garden to find a good smooth place, and while they were walking about there, Rollo's mother came out, and they told her the whole story. She seemed quite interested in the plan, and told them of a better way than any that they had thought of.

"You see," said she, "that the *height* of the stake or pole that makes the shadow is not material; for the shadow of a small one will vary just as much, in proportion to its length, as that of a long one will. So, instead of taking a wooden stake, out of doors, you might take a large pin, and drive it down a little way into the window sill, in the house. Then you can mark the shadow with a pen, very exactly."

"So we can," said Lucy, clapping her hands.

"And you might put a piece of white paper, or a card down first," continued Rollo's mother, "and drive the pin through that, and then mark the places where the end of the shadow comes every day, directly

on the card, with a fine pen. Thus you could be a great deal more exact than you can in chalking upon a barn floor."

Rollo asked his mother if she would not be kind enough to help them fix their apparatus; but she said she would give them particular directions, though she should prefer letting them do the whole themselves, and then, if they met with any difficulties, they might come and report them to her, and she would tell them how to surmount them. So she recommended to them to go and find a blank card, or piece of white pasteboard, or of stiff white paper, as big as a common card. "Then," said she, "choose some window where the sun shines in at noon, and put the card down upon the sill, and drive the pin down through it. But you must not drive the pin through the middle of the card, for the shadow will always be off to the north of the pin, and therefore the pin may be pretty near the south end of the card. Then the shadow will be more likely to come wholly upon the card, even when it is longest. You had better place the card in such a position, too, that its sides shall lie in the direction of

north and south. Then the shadow at noon will lie along exactly in the middle of it. You must get a large and stout pin, too; and drive it in firmly, a little way, with a small hammer. It will be well, too, to drive another smaller pin into the other end of the card, so as to keep it fixed in its north and south position."

"How can we know when it is north and south, exactly?" said Lucy.

"You cannot do it exactly," said Rollo's mother; "but you can get it pretty near. One way is to borrow father's little compass, and adjust it by that. Another way is to see when it is exactly twelve o'clock by the clock, and then the shadow of the pin will of itself be about north.

"Then you might move the north end of the card until the shadow is brought exactly into the middle of the card, and then put the other pin in, and fix it in that place. Then if you make a mark along where the shadow comes, that mark will be a north and south line, and you can mark the place where the shadow of the pin's head crosses that line, when it crosses it every day at noon."

The children said that they believed they understood the directions, and they determined to try the plan. They thought they would fix two cards, one at Rollo's house, and one at Lucy's; and they immediately went off in pursuit of blank cards and big pins.

PRUNING

ONE afternoon, Rollo saw his father coming out into the garden, with a little saw and a knife, and a small pot of paint in his hands.

"Father," said he, "are you going to prune your trees now?"

"Yes," said his father.

"Then, shall I go and get my wheelbarrow?"

"Yes," replied his father, again.

So Rollo ran off after his wheelbarrow. It had been arranged, between him and his father that morning, that they should work in the garden an hour or two in the afternoon, and that Rollo should pick up all the cuttings from the trees, and wheel them away, and then, when they were dry, make a bonfire with them.

Rollo found his wheelbarrow in its proper place, and trundled it along into the garden.

"Father," said he, "what trees are you going to prune first?"

"O, I am going to begin at the back side of the garden, and prune them all, advancing regularly to the front."

"What is the saw for?" said Rollo.

"To saw off the large branches, that I can't cut off easily with a knife."

"But I should not think you would want to saw off any large branches, for so you will lose all the apples that would grow on them next year."

"Why, sometimes, the branches are dead, and then they would do no good, but only be in the way."

"But do they do any hurt?" said Rollo.

"Why, they look badly."

"But, I mean, would they do any actual hurt to the tree?"

"Why, I don't know," said his father; "perhaps they would not. At any rate, if I cut them off pretty close to the living part of the tree, the bark will then gradually extend out over the little stump that I leave, and finally cover it over, and take it all in, as it were."

By this time, Rollo and his father had reached the back side of the garden, and his father showed him the place where he

had cut off a limb the year before, and he saw how the fresh young bark had protruded itself all around it, and was spreading in towards the centre so as to cover it over. Rollo then saw that it was better that all old dead limbs should be cut off.

"That's curious," said Rollo.

"Yes, very curious," said his father. "A tree will take in, and cover up, almost any thing that is fastened to the wood, in the same manner."

"Will it?" said Rollo.

"Yes," said his father. "If you drive a nail into a tree, the bark will, after a time, cover it over entirely. Sometimes people find things in old trees, which were put upon them when they were young."

"How big things?" said Rollo.

"O, I don't know exactly how big. The tree will make an effort to enclose any thing small or large. Only, if it is very large, it will take a great while to enclose it, and it might be so large that it never could enclose it."

"Well, father, how large must it be so that the tree never could enclose it?"

"O, I don't know, exactly. Once I saw

a tree that was growing very near a rock. After a time it came in contact with it, and it grew and pressed against it, until the rock crowded into the wood. Then the bark began to protrude in every direction along the rock, as if it was making an effort to spread out and take the rock all in. But I don't think it will ever succeed; for the rock was part of a ledge in a pretty large hill."

"What a silly tree!" said Rollo.

"Father, I believe I will try the experiment some time," continued Rollo, after a pause.

"Very well," said his father.

"What shall I put into the tree?" asked Rollo.

"You might put in a cent," said his father, "and then, if it should get fairly enclosed, I presume the tree will keep it safe for you a good many years."

Rollo determined to do it. "Then," said he, "I shall never be out of money, and that will be excellent." His father told him that he must make a small cleft in the bark and wood, with a chisel and mallet, and then drive the cent in, edgewise, a little way.

So Rollo got his chisel and mallet, and inserted the cent according to his father's directions, and by that time there were a good many branches and twigs on the ground, which his father had taken off from the trees, and so he began to pick them up, and put them into his wheelbarrow.

They went on working together for some time, and talking while they worked. Rollo was continually asking his father questions, and his father sometimes answered them, and sometimes did not, but was silent and thoughtful, as if he was thinking of something else. But whether he got answers or not, Rollo went on talking.

"Father," said Rollo, at length, after a short pause, during which he had been busily at work putting twigs into his wheelbarrow, "Henry has got a very interesting book."

His father did not answer.

"*I think it is a very interesting book indeed. Should not you like to read it, father?*"

His father was just then reaching up very high to saw off a pretty large limb, and he paid no attention to what Rollo was

saying. So Rollo went on talking half to himself —

“One story is about Aladdin and his lamp. If he rubbed his lamp, he could have whatever he wished ; something would come, I have forgotten what its name was, and bring him whatever he asked for.”

Just then, down came the great branch which his father had been sawing off, falling from its place on the tree to the ground.

Rollo looked at it a moment, and then, when his father began sawing again, he said,

“Should not you like such a lamp, father ?”

“Such a lamp as what, my son ?” said his father.

“Why, such a one as Aladdin’s.”

“Aladdin’s ! why, what do you know of Aladdin’s lamp ?”

“Why, I read about it in Henry’s story book,” said Rollo. “I just told you, father.”

“Did you ?” said his father. “Won’t you just hand me up the paint brush ?”

“Well, father,” said Rollo, as he handed





him the brush, "don't you wish you had an Aladdin's lamp?"

"No, not particularly," said his father.

"O father!" exclaimed Rollo, with surprise, "I am sure *I* do. Don't you wish *I* had such a lamp, father?"

"No," said his father.

"Why, father, I really think I could do some good with it. For instance, I could just rub my lamp, and then have all your trees pruned for you, at once, without any further trouble."

"But that would not be worth while; for you might have a much larger and better garden than this made at once, with thousands of trees, bearing delicious fruit; and ponds, and waterfalls, and beautiful groves."

"O, so I could," said Rollo.

"And, then, how soon do you think you should get tired of it, and want another?"

"O, perhaps, I should want another pretty soon; but then I could have another, you know."

"Yes, and how long do you think you could find happiness, in calling beautiful gardens into existence, one after another?"

"O, I don't know ; — a good while."

"A day?"

"O, yes, father."

"A week?"

"Why, perhaps, I should be tired in a week."

"Then all your power of receiving enjoyment from gardens would be run out and exhausted in a week ; whereas mine, without any Aladdin's lamp, lasts me year after year, pleasantly increasing all the time without ever reaching satiety."

"What is satiety, father?"

"The feeling we experience when we have had so much of a good thing that we are completely tired and sick of it. If I should give a little child as much honey as he could eat, or let him play all the time, or buy him a vast collection of pictures, he would soon get tired of these things."

"O father, I never should get tired of looking at pictures."

"I think you would," said his father.

Here the conversation stopped a few minutes, while Rollo went to wheel away a load of his sticks. Before he returned, he

had prepared himself to renew his argument. He said,

“Father, even if I did get tired of making beautiful gardens, I could then do something else with the lamp, and that would give me new pleasure.”

“Yes, but the new pleasure would be run out and exhausted just as soon as the pleasure of having a garden would have been; so that you would, in a short time, be satiated with every thing, and become completely wretched and miserable.”

“But, father,” said Rollo, after being silent a little while, “I don’t think I should get tired of my beautiful gardens very soon: I don’t think I should get tired even of looking at pictures of them.”

“Should you like to try the experiment?”

“Yes, sir,” said Rollo, very eagerly.

Rollo’s father had a great many books of pictures and engravings of various kinds in his library; and sometimes he used to allow the children to see them, but only a very few at a time. They had not yet seen them all. He only allowed them to see them as fast as they had time to ex-

amine them thoroughly, and read about them and understand them. But now he said to Rollo,

"I could let you have all the books of prints and engravings I have got, and see them all at one time, and that would be giving you Aladdin's lamp, exactly, so far as my pictures are concerned."

"Well," said Rollo, clapping his hands.

"But then, in a short time, you would get tired of looking at them; you would become satiated, and would in fact spoil the whole pleasure by attempting to enjoy it too fast. But then I think it would perhaps do you good."

"How, father?"

"Why, by teaching you the value of moderation, and the uselessness of Aladdin's lamps in all human enjoyments. It would be a very valuable experiment in intellectual philosophy, which I think it very probable might be of use to you. So, if you please, you may try it."

"Well, father, I am sure I should like to see the pictures."

"That is all settled then," said his father; "some day you shall."

THE GREAT BEETLE AND WEDGE.

ROLLO was coming home one morning after having been away on an errand, and he saw a large wood pile near Farmer Cropwell's door. Now it happened that Rollo had once been on a journey pretty far back into the country; it was at the time when Jonas told him and Lucy the stories related in the book called "Jonas's Stories." On that journey, Jonas had one day told him that the sap of the maple-tree was sweet, and had let him taste of some, where it oozed out at the end of the log. Seeing Farmer Cropwell's wood pile reminded Rollo of this; and he thought he would look at the ends of all the logs, and see if he could not find some drops of sweet sap there.

But he could not, for two reasons: none of those trees were maple-trees, and then, besides, they were all dry. There was no sap in them of any kind; at least, not enough to ooze out. While Rollo was look-

ing there, one of Farmer Cropwell's large boys came out with an axe in his hand. He rolled out a pretty large log of wood, though it was not very long, and struck his axe into the end of it, as if he was going to split it.

"I don't believe you can split that great log," said Rollo.

"I don't expect to do it with the axe," said the boy, as he left the axe sticking in the log.

"How then?" said Rollo.

"I have got beetle and wedges here, round behind the wood pile."

So the boy went to another side of the wood pile, and brought a large beetle and an iron wedge. When he got back to his log, he started out the axe which he had left sticking into it. Then Rollo saw that the axe had made a little indentation, or cleft, in the wood. He put the point of the wedge into this cleft, and drove it in a very little, with a few light blows with the axe. Then he took the great heavy beetle, and began driving the wedge in, with very heavy blows.

Presently, Rollo saw a little crack begin-

ning to extend out each side from the wedge. The crack ran along across the end of the log, and thence down the side, and grew wider and wider every moment. At last, the wedge was driven in as far as it would go, and still the log was not split open.

"Now stop," said Rollo; "I will put a stick in, and keep the crack open, while you drive the wedge in, in another place."

"O, that won't do," said the boy; "a stick would not keep it open."

"Why not?" said Rollo.

"Because it is not solid enough; the sides of the cleft draw-together very hard. They would crush the stick."

Here Rollo put his hand into his pocket, and drew out a walnut, and he asked the boy if it would crack a walnut.

"Try it," said the boy.

So Rollo put the walnut into the crack. He slipped it along until he got it to a place where the crack was just wide enough to receive it, and hold it steady. He left it there, and then the boy began to knock out the wedge.

He struck it first upon one side, and then upon the other, and thus gradually worked it

out. The walnut was crushed all to pieces. The boy then drove in the wedge again, so as to open the log as it was before. He then went to the place where he had got the beetle and wedge at first, and brought a large wooden wedge which he had made before, and began to put that into the crack, not very far from the iron wedge.

"This will keep it open," said he.

"Yes, I think it will," said Rollo. "But put it up close to the iron wedge."

"No," said the boy; "for then I can't knock the iron wedge out."

So the boy put the large wooden wedge in, at a little distance from the iron one, and drove it in rather gently with the beetle. This opened the cleft a little more, so that the iron wedge came out pretty easily.

"I don't see what makes the sides of the logs draw together so hard," said Rollo.

"O, they can't help it," said the boy.

"That is no reason," rejoined Rollo. "I should think that, after the log is once split open, it would stay so. If I split a piece of wood in two with my knife, the pieces don't try to come together again."

So Rollo began to examine the log, and

to look into the cracks, to see if he could find out what it was that made the parts draw together so hard as to crush the walnut. Presently, he observed that the log was not split open from end to end. The crack commenced at one end, and extended nearly towards the other, but not quite; so that at this other end the log was solid and whole, just as it always had been. So Rollo perceived that the two halves being joined and held together firmly here, they could only be separated at the other end by the wedge springing them open, and, of course, by their elasticity they tended to spring together again. Then besides, he saw, by looking into the crack, a great number of splinters, large and small, which extended obliquely from one side to the other, and bound the two sides strongly towards each other.

By this time the boy had got the wedge knocked out.

"It is strange," said Rollo, "that such a small wedge will split such a tough and solid log."

"O, not very strange," said the boy. "You see," he continued, taking up the wedge, and pointing to the several parts as

he explained them, "you see here at this part, where it enters the wood it is sharp, and the sides spread out each way, so that, when I drive it in, they force the wood apart."

"Why don't they have the back of the wedge wider still? and then it would force the wood open farther; and then you would not have to put in a wooden wedge afterwards, — so," he added, making a sign with his fingers. He put the tips of his fingers together, and then separated his hands, so as to represent a very blunt-shaped wedge.

"Then it would not drive in so easily," answered the boy. "Perhaps I could not drive it in at all, if it was so blunt."

"They might have the wedge longer then," said Rollo, "and then it would be just as tapering, and yet it would be a great deal broader at the back, because the back would be farther off."

"That would make the wedge a great deal too heavy. It would not drive."

"Why, yes, it would," said Rollo.

"No, it would not," said the boy. "It would be just like a shoemaker's lap-stone; pounding it would hardly move it."

Rollo did not understand what the boy meant by what he said about the shoemaker's lap-stone; so he paused a moment, and presently he said,

"I don't think it would make any difference, if it was heavy. And, besides, it might be made of wood, and that wouldn't be heavy."

"O, wood wouldn't do," said the boy.

Now it happened that while they had been talking, the boy had gone on driving in his wooden wedge into the cleft that the iron one had made, and it had been gradually splitting the log open more and more. So that just as the boy was saying that "a wooden wedge wouldn't do," Rollo was actually seeing with his own eyes that it *would* do; for at that moment the boy gave the last blow, and the halves of the log came apart and fell over, one to one side, and the other to the other.

"Why, there," said Rollo, "you have split the log open with a wooden wedge."

"O, that is because I had an iron one in first," said the boy.

"What difference does that make?" said Rollo.

"A great deal of difference," said the boy.

"But *what* difference?" persisted Rollo.

"I don't know exactly what difference," said the boy; "only I know you can't do any thing with a wooden wedge until you have first opened a seam with an iron one."

Rollo was confident that it could not possibly make any difference whether a wooden wedge was used first or last. The boy was sure that it did, though he could not tell why. Finally, they determined to try it; so the boy struck his axe into the end of the next log, and then attempted to drive in his wooden wedge. But he did not succeed at all. The wedge would not stay. Rollo told him that he did not strike hard enough. Then he struck harder, but it did no good. The wedge dropped out the moment he let go of it, and on taking it up, they found that the edge of it was bruised and battered; so that even Rollo gave up all hopes of making it enter.

"Ah!" said the boy, taking up the wedge, and looking at it, "now I know what the reason is. It is the edge."

"Where?" said Rollo. "Let me see."

"Why, when there is no crack," said the boy, "you see the edge of the wedge comes against the solid wood, and when I drive, it only bruises and batters it; but the iron is hard, and goes in. But then, when a crack is made, the wedge can go in easily; for the edge does not touch; then only the sides rub against the wood."

"How?" said Rollo. "I don't understand."

"I'll show you in a minute," said the boy. So he took the iron wedge, and went to work driving it into the log. It soon began to make a crack, which ran along the log, and opened wider and wider. When, at length, it was pretty wide, he put the wooden wedge in, and he showed Rollo that the edge of the wedge did not now have to force its way, but went easily into the crack, and only the sides came in contact with the two parts of the log which it was separating.

"That's curious," said Rollo.

"Yes," said the boy.

"I wish I had a little beetle and wedge," said Rollo. "I have got a hammer. That would do for a beetle, if I only had a wedge."

"O, a hammer won't do," said the boy.

"Why not? Would not an axe do as well as a beetle?"

"No," said the boy, "it would spoil the axe and the wedge too."

"How?" asked Rollo.

"Why, it would bruise it all up, — hard iron knocking against the hard iron."

"Would it?" said Rollo.

"Yes," replied the farmer's boy; "it would spoil the head of the axe, and the head of the wedge too."

"Is that the reason why they make a wooden beetle?"

"Yes," said the boy; "and they put iron rings around the ends to keep the wood from being bruised and battered."

"O, I wish I had a little beetle and wedge!" said Rollo.

"Perhaps you might make one."

"O, I could not make an iron wedge — nor the beetle rings."

"No, but you might make wedges of wood, — pretty hard wood; that would do to split up pieces of pine boards, and then you would not need any rings to your beetle."

"Jonas can help me," said Rollo.

"Yes," said the boy; "Jonas will know all about it."

So Rollo set out to go home, full of the idea of making a wooden beetle and wedge, so as to split up pieces of boards. He determined, in case he should succeed, to make a smaller one still for Thanny.

THE LITTLE BEETLE AND WEDGE.

WHEN Rollo got home, he looked about for Jonas every where, but could not find him. He went around the house and yard, calling "Jonas! Jonas!" very loud. Presently Nathan came out to the door, and told him that his mother wanted to see him. So Rollo went in to his mother.

"You ought not to make such a noise," said she, "calling Jonas. You disturb us all."

"But, mother," said he, "I want to find him very much."

"No doubt," said his mother; "but you must find him with your eyes, not with your tongue."

"Why, mother," said Rollo, laughing, "what do you mean by that?"

"Boys very generally have a habit of trying to find people with their tongues, that is, by calling them; but it is a very bad habit. You see," she continued, "there

are five or six persons now in and about the house, and if you go around calling out for Jonas, you disturb us all; but if you go about quietly, and *look* for him, you do not disturb any body."

"But then it is not so easy to find him by looking for him," said Rollo.

"Why not?" asked his mother.

"Because," said Rollo, "I can call out for him, in a moment, in the yard, and then if he is any where within hearing, he answers; and so I know where he is. But it would take me some time to go to all the places that are within hearing."

"True," said his mother, "I see it is more trouble to find any body with your eyes, than with your voice; but then it is so much pleasanter for all the rest of us, that you must submit to it."

So Rollo went away again to look for Jonas. He inquired of Dorothy in the kitchen, and she told him that she saw Jonas going out towards the barn a few minutes before. So Rollo went off in pursuit of him.

He found him at work in a little back

room in the barn, looking over some harnesses.

“What are you doing, Jonas?” said Rollo.

“I am overhauling these harnesses, to get them all ready for winter.”

“For winter?” said Rollo.

“Yes,” replied Jonas; “they are sleigh-harnesses.”

“Well, Jonas,” said Rollo, “I wanted to see you about a beetle and wedge. Do you think you could help me about making a little beetle and wedge?”

“I can help you by my *advice*,” said Jonas.

“O, but I want you to help me *make* them.”

Then Jonas asked Rollo what made him think of a beetle and wedge; and Rollo told him of the conversation he had held with the farmer’s boy. Then Jonas talked a long time about it, giving him particular advice and direction about the plan, though he said he could not himself go and help him then, for he could not leave his harnesses.

The advice which Jonas gave him was, substantially, this:—

"The boy was right in what he said about the necessity of having iron wedges, to split up large logs of hard wood ; but you had better have short pieces of pine boards for your logs, and then wedges of hard wood will do instead of iron ; for hard wood is so much more solid than pine, that I think wedges of it will answer very well. There are some pieces of walnut under the bench, which will do finely, and I will give you one of them."

"I'll go, now, and get it," said Rollo.

"No," said Jonas, "not yet; let me tell you about making the beetle."

So Rollo stood in the door way, waiting to hear what Jonas had to say about the beetle, but evidently quite impatient to go.

"If you make your wedges of hard wood, it will not be necessary to have iron rings to your beetle, because it will not get battered much, in driving wooden wedges. Now you must go to the wood pile, and look out a piece of round wood, about as large round as my arm, and bore a hole in it."

"A hole in it !" said Rollo.

"Yes, a small auger hole, to put the handle into. Then you must put the wood

into the saw-horse, and saw off the ends, at a little distance from the hole, so that, when the handle is put in, it will be like a mallet."

"A mallet!" said Rollo. "But I wanted a beetle."

"Well, a mallet is a small beetle, without rings."

"Is it?" said Rollo, thoughtfully.

"Yes," replied Jonas; "and if you work slowly and carefully, I think you can make a pretty good one yourself."

Rollo thought so too, and away he ran to make the experiment. Under the great work bench, he found, among a quantity of boards and bits of wood, a number of long bars of walnut, which Jonas had split out from the wood pile to keep for handles. He took one of these, and carried it off to the shed, to look for the saw and the hatchet.

The first thing was, as he supposed, to saw off a piece of the wood just long enough for a wedge. But in this he was mistaken. In doing any piece of work of this kind, it is always very important to consider which part it is best to do first. Rollo did not think of this, and so he marked off a piece

of the walnut wood about long enough for a wedge, and then sawed it off.

"Now," said he, "I must make the sides smooth, and sharpen it."

So he took the piece of wood in his hand, and put one end of it down upon a large log of wood, and then attempted to smooth and sharpen it, as he had seen Jonas sharpen a stake. But he could not succeed very well. The wood was very hard, and he could not cut it. Then it was so short that it was almost impossible to hold it. At almost every blow of the hatchet it slipped out of his hand; and then, besides, he was very much afraid of cutting his fingers; so that, after working laboriously for some time, he came back to Jonas in despair, holding his wedge in his hands, which, however, instead of being properly sharpened, was only rounded off a little at the corners.

"O dear me!" said he to Jonas, as he came up to him with the intended wedge in his hands, "I can't make a wedge at all. It's no use to try." Then he explained to Jonas the difficulties that he had met with.

"True," said Jonas; "I see. I advise you to give it up."

"Yes," said Rollo, "the wood is so hard."

"O, no," said Jonas; "*that* is no great trouble — you could easily manage that."

"But then I can't hold it."

"That is of no consequence either. I could tell you a way to hold it well enough."

"What is the reason, then, why you think I had better give up?"

"Because you have not patience enough."

Rollo stood silent and thoughtful as Jonas said this, with his piece of wood in one hand, and his hatchet in the other.

"It takes a great deal of patience to make a thing which we never made before."

"Why?" said Rollo.

"O, because there are always unforeseen difficulties. We don't know exactly how to do it, and are apt to make mistakes; and so we spoil some of our work, and this makes us impatient and fretful."

"But I could not help coming to you," said Rollo, "when I found I could not sharpen my wedge."

"I did not blame you for coming to me," said Jonas.

"But you said I was impatient."

"Yes, but not for coming to me — I

judged by your looks and tone of voice. Now if you can keep good-natured and pleasant, so as to go on steadily and patiently, difficulties or no difficulties, I will help you by my advice; otherwise, I think you had better give up the plan."

Rollo stood a few minutes leaning on the door, and swinging it back and forth a little. He seemed to be in doubt whether to be good-natured or not. At length, the better feelings triumphed, and he said,

"Well, Jonas I will try. How can I hold my wedge while I sharpen it?"

"You must not saw it off until it is all sharpened and smoothed. By that means, you see, the long end of the stick, that you make it from, will serve for a handle."

"So it will," said Rollo; "I never thought of that."

So Rollo went off in pursuit of the stick from which he had sawed off his first wedge, intending to make another upon the end of it, and then saw it off when it was all ready.

He found that now he could hold his wood very easily, and there was no danger of cutting his fingers. So he could strike much heavier blows. He soon sharpened

his wedge, and then carried it to Jonas to ask him if he thought it would do.

"No," said Jonas, "I don't think it will do, very well."

"Won't it?" asked Rollo, looking somewhat disappointed.

"Why, you see the sides are not smooth; and then you have not sharpened it uniformly. You have cut away more at the corners than you have in the middle, so that it is thicker in the middle. That is the way that boys always sharpen wedges."

"Why do they?" asked Rollo.

"I suppose it is because it is easier to cut away at the edges, and so they get more off there. Now you had better get your wedge as true, and perfect, and smooth as you can, before you saw it off. It will be a great deal pleasanter to work with a good wedge than with a poor one, and so you had better take pains with it, and make as perfect a one as you can, if you make any."

"But, Jonas," said Rollo, "I can smooth it and finish it, after I get it sawed off."

"Not half as easily as you can now," said Jonas.

During all this time Jonas kept on with

his own work ; and now he said no more, and seemed disposed to leave Rollo to his own decision.

Rollo walked slowly back to the shed. He longed to have his wedge done ; but then Jonas had often told him before, that if he was attempting to make any thing, it was best to take pains with it, and make it as complete and perfect as possible, and then he would prize it more, and take more pleasure in it, when it was done. Rollo knew that this was good advice, though, like almost all other boys, he was always in such a hurry to finish any thing that he undertook, and to have it ready for use, that he did not like to take the necessary pains.

On reflection, however, he concluded to take Jonas's advice ; and he accordingly began to smooth the sides of his wedge again with the hatchet. He did it slowly and carefully ; and after some time he found that he had got the wedge into a much more perfect shape than before. He then carried it to Jonas again.

Now Jonas approved it very much, but told him that he had better smooth it a little more with his knife before sawing it off.

Rollo did so; and then he carried it back to the horse, and sawed it off at the right distance, and it made an excellent wedge. The edges, at the head of the wedge, were left somewhat rough by the saw. These, however, he trimmed off with his knife, and then carried the wedge to Jonas.

"Very well," said Jonas; "now you want one more."

"One more?" said Rollo. "No, I want my beetle next."

"No," said Jonas, "one more wedge. Make all your wedges first."

"Why, Jonas, you see, if I make my beetle next, I can try it with this wedge, and then I can make another, if I want it, afterwards."

"No," replied Jonas, "that is not a good way. You ought to finish up your apparatus all complete, before you try it at all. Then you will take a great deal more pleasure in trying it. Besides, if you get to work splitting up your wood, you will not want to leave it, and go to making a new wedge then. Now is the time to do it."

Rollo felt very desirous to make his beetle first, so as "just to try it a little," as he

said. Still, he had so often found, when he had not followed Jonas's advice, that he was sorry for it afterwards, that he concluded to make another wedge now. He accordingly went to work again, and having learned how to do it by his practice upon the first one, he succeeded very easily, and finished it much quicker than he did before.

Then he went to work upon his beetle. He selected a round stick of wood, of about the right size, and then examined it carefully to find the part which was most uniform and regular in its shape ; and he bored a hole for the handle in the middle of this part. He made his handle of pine wood, for this was much easier to cut, and Jonas told him he thought it would do nearly as well. When the handle was finished, he drove it into the hole, and then he sawed off the ends of the stick of wood at the right distances from the hole. He first took pains to measure on each side, so as to have the distances exactly the same.

When this was done, he had quite a pretty little mallet. That is, it was made very much like a carpenter's mallet ; still, as a mallet is made chiefly for the purpose of

driving a chisel, and this was, on the other hand, only intended to be used for splitting wood with a wedge, Jonas told him he thought it would be strictly proper to call it a *little beetle*. He worked so slowly and carefully, however, in doing all this, that the afternoon had entirely passed away when he got the beetle and the wedges done; and just when he was thinking that he was ready to try them, he saw Dorothy at the kitchen door, ringing the bell to call him in to tea.

SPLITTING.

WHEN play time came the next day, Rollo ran after Nathan to show him his beetle and wedges, and to get him to go out and see him 'split' with them. Nathan trotted along after him, very much pleased.

Rollo had his beetle in one hand, and his two wedges in the other, and, as he walked along, he looked over his shoulder towards Nathan, who was following him, and talked to him by the way, explaining to him something about his beetle and wedges.

"You see I am going to split, Thanny. I am going to split some kindling wood for Dorothy. I shall put my wedges into the wood, and then drive them in with my beetle, and that will make the wood split open more and more; and perhaps I will let you split a little, Thanny."

By this time Rollo had got out to the shed, and he put his beetle and wedges down upon the floor, while he went away

to get some boards to split. There were some old boards behind the barn, which Jonas told him were to be split up to burn, and from these he chose one, which was not very long, and dragged it to the shed. He placed this upon the saw-horse, and then sawed off a piece from one end, about as long as he thought it would be well to have the sticks of kindling wood. After he had sawed off one piece, he was going to split it up, but then he reflected that it would be more systematic and workmanlike to finish his sawing first. So he sawed off another, and another piece, until the board was all sawed up into short pieces. He placed these together neatly in a pile, and then taking one of them, he sat down upon the floor, with Thanny, and prepared to try his beetle and wedges.

“Now,” said Rollo, “I think I must have a knife, — some old knife or other, — to make a little place to drive my wedge in. Thanny, why can’t you go and ask Dorothy to let me have a knife? Come, that’s a good boy.”

So Nathan got up off of the floor, where he had been sitting by Rollo’s side, and





went in for a knife. In a few minutes he came out, and asked Rollo if a broken one would do. He had brought out a broken knife. The handle was whole and strong, but the blade was broken in two, about in the middle.

"Why, yes," said Rollo, taking the knife and looking at it, "I believe that will do.

"Yes," he continued, "I shall like this better, for I can keep this all the time, with my wedges. And besides, I believe that I can drive it better."

So Rollo held the edge of the knife to the end of the board, and then drove it in a little way, with his little beetle. This made a small opening or cleft in the angle or edge of the board at one end. Then he began to drive in his wooden wedge, telling Nathan to look carefully and see when it began to split. Nathan stood near him, stooping down, with his hands upon his knees, and looking on with great attention.

Rollo drove in his wedge, and it proceeded admirably. The wood soon began to crack, and the crack gradually extended almost to the end of the board. When he had driven it in pretty far, he told Nathan to see how he

was going to manage with his second wedge. He was now very glad that he had followed Jonas's advice, and made the second wedge before trying the first. He inserted the second wedge in the crack, and drove it in. This forced the wood open more, and loosened the first wedge, so that he could easily get it out again, and very soon the board was split entirely in two. Nathan was very much delighted with the whole operation.

In the same manner, Rollo split two or three other pieces off from his board, and then Nathan wanted him to let *him* split one. Rollo was at first somewhat unwilling to let his little beetle go out of his hand at all, he was so interested in using it; but considering that it would give Nathan a good deal of pleasure, he concluded to let him try it once.

"I will start it for you, Thanny," said he. And he accordingly made a small cleft by driving in his knife; and then he inserted the wedge, and drove that in too, just far enough to start the crack, and enable the wood to retain the wedge. Nathan then took the beetle, and pounded away.

He found that he could not strike such heavy blows as Rollo could, and yet the wedge gradually penetrated farther and farther, and the crack opened wider and wider, to Nathan's great delight. Rollo was himself gratified to see how much his little brother was pleased with his beetle and wedges. When the first wedge was driven fully in, he handed him the other, and showed him how to insert that into the crack made by the first wedge, at a little distance from it. Nathan then drove in the second wedge, and this soon finished the work, for it split the piece off entirely, and Nathan took it up, and looked at it, very much pleased at what he had done.

"Now," said Rollo, "give me the beetle again."

"No," said Nathan, "I want to split some more."

"O, no," said Rollo, in a tone of good-humored expostulation; "no; it is *my* beetle and wedge. I let you have it to split one stick off; but now you ought to let me have it again, immediately."

"No," said Nathan, "I want to split some more."

Rollo took up the two wedges, and would not let Nathan have them, and Nathan held the beetle away behind him so that Rollo should not have that. Thus they seemed to be in inextricable difficulty. Rollo did not know what to do.

"Nathan," said he, at length, after a pause, "give me my beetle."

"No," said Nathan, "*I* want to split."

"O, dear me!" said Rollo, with a sigh.

At first, he thought that he would take the beetle away from Nathan by force; but he reflected in a moment that this would be wrong, and so finally he concluded to go and state the case to his mother.

So he rose, and began to walk away, saying,

"Well, Nathan, I mean to go and tell mother, that you won't let me have my beetle."

Then Nathan, whose conscience secretly reproved him for what he was doing, pulled the beetle round from behind him, and threw it down upon the floor, where Rollo had been sitting. This was wrong. It was a very ill-natured way of giving it up. If he was satisfied that he was wrong, he ought to

have handed it to Rollo pleasantly. Instead of that, he threw it down, with a sullen look, and sat still.

Then Rollo, thinking that it was now no longer necessary to go and trouble his mother with the difficulty, began to return. As he came back, he said, in a kind and soothing tone,

“Now, you are a good boy, Nathan. That is right — to give me back my beetle. Now I will let you split again, some time.”

But Rollo was mistaken in supposing that Nathan was a good boy. Boys are not good until their *hearts* are right. When a child has something which he ought not to have, it is not enough for him to throw it down upon the floor, sullenly, because he is afraid to have his father or mother told that he has got it. He ought to give it up pleasantly, and feel that it is right that he should do so. If Nathan had said to himself, “I ought not to keep this beetle, for it is not mine — it is Rollo’s; he made it, and he has been kind enough to lend it to me, and now I ought to be willing to give it back to him pleasantly again;” and then had given it to him with a pleasant countenance, — that would have

been really being a good boy. But to throw it down in a pet, because he was afraid to have Rollo complain to his mother, was very far from being like a good boy.

However, it was very kind in Rollo to speak soothingly and pleasantly to Nathan ; though, if he had reflected how much goodness depends upon the state of the heart, he would not have supposed that Nathan was yet a good boy. In fact, when he saw that Rollo was coming back again, and was not going to his mother, after standing still, looking quite sullen for a moment, he suddenly stooped down, seized Rollo's knife, and ran off with it out into the yard.

Rollo instantly pursued him, calling out, "Nathan ! bring back my knife ; Nathan . Nathan ! give me my knife."

Nathan, however, ran on, though Rollo ran the fastest, and was rapidly overtaking him ; and just at the instant before he reached him, Nathan's foot tripped ; he fell, and as he threw forward his hands to try to save himself, they came down upon the ground, and his forehead struck the corner of the knife blade. He immediately screamed out

with pain and terror. Dorothy, alarmed by his cries, came out, took him up in her arms, and carried him into the house.

She took him to the table, and began to bathe the wounded forehead in cold water. This was what she always did when the children got cut or scratched, or hurt in any such way. It prevents inflammation. She saw that Nathan was not hurt much, though he continued to cry very loud. His crying was, however, partly from pain, and partly from vexation.

In a few minutes, Rollo's mother came down stairs to see what was the matter. Rollo thought that his mother might suppose that he had hurt Nathan, and so he began to explain at once how it happened. But his mother held up her hand to him, as a signal for him to be silent. She knew that it was then no time to ascertain the facts.

She came up and looked at Nathan's forehead a moment, and she saw that it was not much hurt. Besides, she knew, by the sound of Nathan's cries, that they did not proceed from much pain. She therefore said to him, gently,

“ Stop crying, Nathan ! ”

Now Nathan knew that his mother did not tell him not to cry, except when she was sure that he could control himself if he chose to do so; and he also knew that she punished him if he did not obey. So he began immediately to repress his sobs and cries, and very soon became still. She then put a small plaster, of some sort, upon his forehead, and then carried him up stairs and laid him on the bed.

"'There,'" said she, "'Thanny, lie still there a little while, till your forehead has done aching, and you get pleasant again; then you may get up, and come to me.'"

Then she went to her work again, and Rollo came and stood by her side, and told her the whole story.

"Nathan did wrong," said she; "but it would have been better for you not to have run after him."

"Why, mother," said Rollo, "he was running away with my knife; and I can't split at all without my knife. One thing I know, — I shall not let him split any more with my beetle and wedges."

"That would be one way to treat him,"

said his mother ; "but there is another thing you might do, if you chose."

"What, mother?" asked Rollo.

"Why, make him a beetle and wedge, for his own."

"Why, mother!" said Rollo, with surprise.

"Yes," said she. "You might make him one. Think how pleased he would be with it. Then he could sit down with you, and you could both be splitting together."

"But, seems to me, mother, that that would be rewarding him for being a naughty boy."

"It would be so, if you were to make him a beetle and wedge, *because he was a bad boy* ; but I proposed that you should make it for another reason, that is, to *please* him."

"But perhaps he would *think* I did it because he ran away with my knife," said Rollo.

"I don't think there is any danger that he would imagine that you did it as a reward for that," replied his mother.

Here Rollo paused a moment. He did

not feel quite ready to undertake to make Nathan a beetle and wedges ; but he did not know exactly how to reply to his mother's reasoning. At length he said, in a timid and hesitating voice,

"But, mother, it seems to me that it would be better to punish Nathan, rather than reward him, or do any thing which would seem like rewarding him for acting so."

"That may be true," said his mother. "And it is true, also, that if you should refuse to let him split wood any more with your wedges, it would be punishing him ; while, on the other hand, if you should make him a little beetle and wedge of his own, it would be forgiving him. Now I do not say that he ought not to be punished ; but which do you think is *your* duty towards him, — you, yourself, being only another child, a few years older than he, — to punish or to forgive ?"

"Why, — to forgive, — I suppose," said Rollo, rather doubtfully.

"I am rather inclined to that opinion, myself," said his mother : "but you can do just as you please."

Rollo remained some minutes about his

mother's chair, not knowing exactly what to do or say next. He sat down upon the floor, and began to play with some shreds of cloth which were lying there. Presently, he looked up and said,

"Mother, what was the reason why you would not let me tell you what was the matter with Nathan in the kitchen?"

"Because," said she, "he was crying then, and it is no time to learn how an injury happened, during the excitement of the moment. If you find Nathan crying out in the yard, for instance, and try to get him to tell you how he got hurt, you only make him cry the more. Get him quiet first, and then learn the story afterwards.

"Then, besides the difficulty of his speaking intelligibly," she continued, "at such a time, boys are very strongly tempted to misrepresent the facts, during the excitement of the first moments. They are very likely to be a little vexed or angry, and, under the influence of those feelings, not to give a correct and honest account. So that it is always best to put off inquiries till the trouble is all over."

Here Nathan came into the room. His forehead had ceased to give him pain, and so he had clambered down from the bed where his mother had placed him, and now came into the room, looking quiet and calm, though still not very happy.

Rollo went to him, and said, "Come, Nathan, now we will go down stairs to play again." And he began to lead him down stairs. As they walked along, Rollo said,

"I am going to make you a beetle and wedge for your own, Nathan, and then you and I can split together: only, it is not a *reward*, you must understand. It was wrong for you to keep my beetle, and run away with my knife, and you are sorry you did so, an't you, Nathan?"

"Yes," said Nathan.

"And you won't do so any more, will you, Nathan?"

"No," said Nathan, "I won't do so any more."

Whether Nathan was really sorry for what he had done, or whether he only said so because Rollo was going to make him a beetle, is very doubtful; though it is not impossible that he was a little sorry.

Rollo went down into the shed again with Nathan ; and while he was at work making the new beetle and wedge, he let Nathan use his. The first piece of board had been split up ; so he laid another one before Nathan, and gave him his beetle and wedges and knife, and then went away out to the barn to get some more wood for wedges, and an auger.

When he came back, he found Nathan standing at the shed door, with the little beetle in his hand, waiting for him. As Nathan saw Rollo coming, he called to him, saying,

“Come, Rollo, come and help me ; the board won’t split.”

“What is the matter with it?” said Rollo.

“I don’t know,” said Nathan, “only it won’t split.”

So Rollo went in to see. He found that Nathan had gone to work wrong. Instead of trying to drive the wedge into the *end* of the board, so as to split it *along* the grain, he had made the cleft with the knife in the side of the board, and was attempting to

drive it in there, as if he supposed he could split the board *across* the grain.

"Why, Nathan," said Rollo, "that isn't right. You can't split it across."

Then he put the wedge into the end, where it ought to be put, and set Nathan to driving it. *Now* it began to split at once; though Nathan could not see why the board should not split one way as well as the other.

Rollo himself did not understand it very well. Nathan asked him why it would not split the other way, and he said that that was *across* the grain. But when Nathan asked him what he meant by *grain*, he could not tell.

He took up the wood and examined it, and observed little lines and ridges, running along in the direction in which it would split; but at the ends of the board, where it had been sawed across the grain, it was rough. He determined to ask Jonas about it, or his father.

He then went to work, and made the wedges and a little beetle for Nathan. He made Nathan's beetle smaller than his own,

because Nathan was not strong enough to strike hard with such a heavy beetle. He did not get it done in season to use that day; but, the next day, he and Nathan sat down upon the shed floor, and spent an hour in splitting up the boards. They split them all up into good, fine kindling wood. Then they piled the pieces up in a neat pile, and then brought Dorothy out to see them.

Dorothy seemed very much pleased; and promised the boys that, the next time she baked pies, she would kindle the fire in the oven with their kindling wood, and then she would bake them each a little apple turnover.

That evening, just before Rollo went to bed, he asked Jonas if he could tell him why boards would only split *along* the grain.

"Yes," said Jonas, "I think I can tell you. But do you know what the grain is?"

"No," said Rollo, "I don't know any thing about it."

"You know that boards are made from the stems of tall trees."

"Yes," said Rollo.

"Well, now when trees are growing, there are little channels running up and down from the roots to the branches."

"What are they for?" said Rollo.

"They are for the sap. The sap flows up and down in them. But then there are no channels across from one side of the tree to the other, because there is no sap to go across. The sap all has to go up from the roots to the branches; and so the channels must all be up and down the tree.

"Now," continued Jonas, "when they cut down the tree, the trunk will split easily, up and down, the way the channels and fibres all go; but it won't split easily across. And just so, when they saw it up into boards, the boards will all split lengthwise, from end to end, for this is the way the channels and fibres all lie; but it won't split across, for that would be across all the fibres, and the wood is made very strong in that direction, and it is well it is so."

"Why?" said Rollo.

"Because, if trees would split across, as easily as they do up and down, the first good

wind would blow down all the forests in the world."

"O, Jonas!" exclaimed Rollo, "all the forests in the world?"

"Yes," replied Jonas, "if the wind blew all over the world."

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HOROLOGY

HOROLOGY.

ONE day at eleven o'clock, Rollo, after having put away his books carefully into his desk, went out to play. It was a calm and pleasant autumnal day. Brown and yellow leaves were falling from the trees, and lying about the yard. Rollo found Nathan sitting upon the steps of the door which looked toward the garden yard. He felt satisfied and happy, for he had studied his lessons diligently, and, when he saw Nathan, he concluded to have a little play with him.

"Now, Nathan," said Rollo, "I will lie down upon the steps, and make believe I am a bear gone to sleep, and you come and poke me with your stick, and then I will growl at you."

"Well," said Nathan, "I will."

So Rollo laid down upon the steps, putting his arms upon the threshold of the door for a pillow, and his head upon his arms, and pre-

tended to be asleep; but he did not look much as if he was asleep, after all, for he could not look quite sober. He tried to look sober; but there was a lurking smile upon his face, which made his countenance look quite different from that of a bear. Nathan came creeping along softly, and when he got near enough, he began to poke him with the end of his little whip-handle; then Rollo would start up and begin to growl, when Nathan would scamper away, shouting with laughter, Rollo after him, upon all-fours.

This play lasted several minutes, until at length Nathan spoiled it by punching Rollo too hard with his whip-handle. A great many plays are spoiled by roughness on the part of some who are engaged. Rollo, being hurt a little, got out of patience. He ought to have asked Nathan, pleasantly, not to punch him so hard. Instead of that, however, he declared that he would not play any more, and got up and went away. Nathan followed him, lashing the ground and the leaves with his whip.

They both went into a corner of the yard, where Rollo used to have his sand-

garden. This sand-garden was made of clean sand, which Rollo and his cousin James once wheeled up from the brook ; and then, after they had smoothed it out, and raked it over, they used to get plants and flowers, without any roots, and stick down, and then call it their garden. They used to water the plants, and so they could keep them green and bright for several days, which was long enough for them ; for, after that, they generally preferred putting down fresh ones. But, now, the sand-garden had been for a long time neglected. The remains of some of the old plants were there, withered and dried, and the leaves of autumn were scattered over its surface.

Rollo began to rake off the leaves with his fingers, and then sat down, and went to digging a hole in the sand. It was very dry upon the top, but on digging down a little way, he found it damp, and so it would hold together pretty well, and he could pat it into any shape. A load of clean sand makes a very good place for children to play in, in a corner of a yard.

Rollo sat down on one side of the sand-garden, and Nathan on the other, and both

busied themselves in digging and building little houses. They both became very much interested, and sat some time very still, until, at length, Rollo looked around to see what Nathan might be doing.

“What are you doing, Thanny?” said he.

“O, I’m making the sand run down through.”

Rollo observed that Nathan had an old tin dipper, which he was holding up in one hand, and putting some dry sand into it with the other. There was a very small hole in the bottom of the dipper, for it was an old one which had been worn out and thrown away; and the sand ran out of this little hole in a fine stream, and it was this which interested Nathan so much.

“O, Nathan,” said Rollo, “let me have the dipper.”

“No,” said Nathan, “I want it myself.”

Rollo would not take it away from Nathan, though he wanted it very much indeed.

“Yes, Nathan,” said he, “let me have the dipper, and I will make you an hour-glass out of it.”

But Nathan said, “No, no,” and moved away a little farther.

Rollo then remembered that such a little boy was generally not interested in any one thing very long, and that, if he should let Nathan alone, he would soon put the dipper down, and then he could have it without any difficulty. So he went on making houses in the sand, and in a few minutes Nathan put the dipper down. Then, soon after, Rollo took it up and put some dry sand into it, and he found that the sand would run very smoothly, in a fine stream, through a small hole there was in the bottom of it.

He determined to make an hour-glass of it. He had seen an hour-glass at his uncle George's. It was made of glass, big at the bottom and at the top, and narrow in the middle between the two. Through the narrow part in the middle, there was a very small hole, to let the sand run down through ; and there was just sand enough put in to run through in an hour. So that, if a person should set the sand to running, he would know when an hour had expired, by observing when the sand had all run through.

Rollo thought that he could make an hour-glass ; and he thought it would be a great convenience to him to have an hour-glass in

the yard ; because it often happened, when he came out to play, that his mother would tell him that he might stay out an hour ; and then he had to go in very often to look at the clock, in order to know exactly when the hour had expired.

There were, however, so many little sticks and old leaves in the sand, that it kept getting continually clogged up, and at last Rollo began to get discouraged. He tried to pick out the little sticks ; but he found he could not do that, and at last it occurred to him that probably Dorothy had some sand in the house that was cleaner.

He accordingly went in and asked her. She told him that he must wash his own sand, and that would make it clean.

“ But haven’t you got some that is clean already ? ” said he.

“ Yes,” said Dorothy ; “ but you will like your hour-glass better if you make it all yourself.”

So Dorothy told him how to wash sand, for Rollo said that he did not know. She said he must put a little in a basin, and then pump water into it. “ When the basin is nearly full of water, you must stir it round,

and then pour off the water, and pump in more ; — do this until the water comes off clear.”

So Rollo took the basin which Dorothy gave him, and went out to his sand-garden, and put in a little sand. Then he went to the pump, and pumped water into it. Then he stirred it about with his hand. The water immediately became very turbid, and a great many little sticks and leaves came floating up to the surface. Rollo was surprised to find how rapidly the water separated the light things which would float upon the top, from the heavy sand which would sink to the bottom. He kept pouring off the water, and pumping in more, until at length no more sticks and leaves came off, and the water appeared pretty clear. Then he carried the sand away, and spread it out upon a clean board in the sun to dry.

While he was thus at work preparing the sand for his hour-glass, Jonas happened to come by, and asked Rollo what he was doing. Rollo told him that he was making an hour-glass. Jonas looked on for a few minutes, and then he told Rollo that he thought that was a pretty good plan. “And

I am going to have a time-keeper, too," said he.

"Are you?" said Rollo. "What?"

"I am going to make a dial," said he.

"A dial!" said Rollo; "what, a real dial?"

Rollo had an idea that a dial was exceedingly complicated and difficult to make, or to understand; and, in fact, it is difficult to make one that shall be exact in its indications. He did not think it possible that Jonas could make one.

"Yes," said Jonas, "a real dial; and I have got a noon mark already."

"A noon mark!" said Rollo; "what is a noon mark?"

"It is a mark to show when it is exactly twelve o'clock."

"Let me go and see it," said Rollo, "while my sand is drying."

Rollo followed Jonas off into the barn, and when there, Jonas pointed to a small line which he had cut with his penknife upon the barn floor. It began at the foot of one of the posts, by the side of the door, and extended back into the barn exactly straight.

"Is that the noon mark?" said Rollo.

He was surprised to see that a noon mark was nothing but a cut with a penknife upon a barn floor.

“Yes,” said Jonas; “that is a meridian.”

“A meridian!” said Rollo, looking upon it with an air of great curiosity and respect.

“Yes,” said Jonas; “a line drawn exactly north and south, is called a meridian line; and that is exactly north and south.”

“What do you call it a noon mark for?” said Rollo.

“Because,” said Jonas, “the shadow of the edge of the door post will always be exactly upon it at noon. So that I can always tell now when it is noon, by the shadow of the post upon my noon mark, if the sun shines.”

All this was very new and very curious to Rollo. He had never seen or heard of a noon mark before; and it seemed to him a very simple and beautiful way of knowing when it was noon. He asked Jonas how he found out about it, and Jonas told him that he had been reading about it in a book on astronomy.

“Your father let me have the book,” said he; “and see my chalk marks for the sun’s shadow.”

Rollo looked, and found that Jonas had put down quite a number of chalk marks along in a line, where they had first began to mark the place where the shadow of the door reached into. Rollo and Lucy had forgotten all about their plan of making such a series of observations; but Jonas had gone on regularly, making a mark every Monday, at noon, precisely. As the sun, at that season of the year, was going round farther and farther to the south every week, it shone in farther and farther upon the floor, so that each chalk mark was farther in than the one made the week before.

In order to make his marks at the right time, Jonas wanted to know, every Monday, when it was precisely twelve o'clock, and this led him to make his noon mark, having seen the account of it in the book which Rollo's father had lent him. He learned there that the shadows of all upright objects are cast exactly north at twelve o'clock, or rather very nearly north; near enough for his purposes. Now, as the post of the barn door was upright, he knew that the shadow of it would be in the north and south line at noon. Of course, if he had a north and

south line, or a meridian line, as it was called in the book, drawn upon the floor, he knew that he could tell when it was noon, by the shadow of the post coming then exactly upon that line. He explained this all to Rollo, and Rollo was very much pleased with it indeed. He determined to have a noon line somewhere in the house.

Rollo asked Jonas what was the way to draw a noon line. Jonas told him that there were several ways. One way, he said, was to observe some day, by the clock, when it was exactly noon, and then to mark, upon the barn floor, the line where the shadow of the edge of the post fell precisely at that moment. Another way was to get a compass needle, and put it down upon the floor, and then draw a north and south line precisely in the direction that the needle indicated. That would, of course, be a north and south line, because the compass needle always pointed north and south. He said that he adopted both these methods to make his noon line. First, he got a compass needle, which Rollo's father had lent him, and put that down upon the barn floor just at the foot of the door post, and observed

the direction ; and he also noticed when it was twelve, by the clock in the house, and he found that, when it was twelve by the clock, the shadow of the post came exactly to the line indicated by the direction of the compass needle ; and so he knew that that was a correct meridian line.

JONAS'S DIAL.

THAT evening, Rollo told his father about his hour-glass, and also about Jonas's noon line. His father said it was very difficult to draw a meridian line.

"O no, father," said Rollo; "Jonas has drawn one, and he told me how, and it was a very easy way."

"Yes," said his father, "it is easy to draw something which you can call a noon mark; but it is a very difficult and delicate operation to do it with any considerable degree of exactness."

"I think that Jonas's is exact," said Rollo.

"It probably may be as exact as he could make it with his means and instruments; but there are a great many sources of error which he could not possibly have avoided."

"What?" asked Rollo.

"Why, in the first place, the clock is not exact. It is near enough to answer all the

purposes of a family ; but it may often be a minute or more out of the way. Then besides, while Jonas is going from the clock out to the barn, the shadow is slowly moving on, all the time ; so that he cannot tell exactly where the shadow was, when it was precisely twelve by the clock.

“ Then again, it is not always exactly noon when the shadow comes to the north and south line. It varies a little at different seasons of the year, though it is so near that we say, in general terms, that at noon all shadows of upright objects point to the north. Still, it is not *precisely* true, except on a very few days in the year. Then, again, the post of the barn door is not exactly upright.”

“ I thought they always made door posts exactly upright,” said Rollo.

“ They do make them as nearly upright as they can, with the common carpenters' instruments ; but they are not *exact*. To set a post of any kind, with great precision, perpendicular to the horizon, would require very expensive mathematical instruments, and very laborious and nice observations. Then, again, if the clock had been exact, and the post perfectly upright, Jonas could

not have marked the place of the shadow exactly. The shadow has not an exact and well-defined edge; and then, even while he was marking at one end, the shadow would be moving along at the other end, and so his noon mark would not be exactly straight."

"Why, father, he could make the mark right along quick."

"No matter how quick he might make it. It would take some time, wouldn't it?"

"Only a *very little*," said Rollo.

"And do you suppose the sun would stand still, even during that little time, so as to let the shadow remain stationary?"

"However," continued his father, "I don't say this to disparage Jonas's noon mark. I dare say, it is accurate enough for his purposes. He only wants to know from it when it is time for him to come in to dinner, or something like that. I only want you to understand what exactness is, and to see, a little, how difficult it is to attain to any considerable degree of it, in such cases. So thus, it seems, that Jonas has got a sort of a dial?"

"Why, it only tells him what o'clock it

is at one hour in the day," said Rollo
"But I think he might make it do for all
the afternoon and forenoon."

"How?" inquired his father.

"Why, all he has got to do is to watch
some day when it is nine o'clock, and ten
o'clock, and so on, every hour; and then
make a line where the shadow comes every
hour, just as he did for twelve o'clock.
Then he will have marks for every hour in
the day, and when the shadow comes along
to these marks, one after another, he will
know what time it is."

"O, but the difficulty is," said his father,
"that the shadow will not come to the same
places, at the same hours, on different days.
It will come to the *meridian line*, at twelve,
always, — that is, nearly to it; but it will
not come to any other lines regularly, — that
is, if the object, which casts the shadow,
is upright."

"Will any other kind of object carry the
shadow regularly?" asked Rollo.

"Yes," said his father, "an object that
leans over to the north, so as to point to the
North Star. If you and Jonas could put a
post into the ground so as to have it point

to the North Star, then you could mark, all around it, the places to which the shadow would come for every hour in the day, and afterwards it would come to the same places regularly, or nearly so. It would be near enough for your purposes; and I don't know but that it would be quite a respectable dial for you."

Rollo then asked his father why it was that a post, which pointed to the North Star, would bring a shadow any more regularly to the hour marks, than an upright one would; but he said that Rollo did not know enough, yet, to understand the explanation, even if he were to try to explain it. "Therefore," said he, "you must wait until you study astronomy before you can expect to understand it; but you can now, in the mean time, make such a dial, if you wish to do it."

Rollo did wish to do it very much. He accordingly told Jonas all that his father had said. It seemed very strange to Jonas, that a post, pointing to the North Star, should have its shadows move round any more regularly than a post in any other position. He could not imagine what the North Star

could have to do with the shadows. Still, he determined to try the experiment.

A few days after this, Jonas did try the experiment. He got two narrow boards, which were once pickets belonging to a picket fence, one end of each was sharp, so that it could be driven down into the ground. Then he selected a certain part of the yard, in a corner, where the dial would be out of the way, and yet the path to the barn led along pretty near it. The reason why Jonas got two boards was this: he knew that, if he drove only one stake into the ground, and inclined it towards the North Star, it would be very likely to get started out of its proper position; but if he had two, he could drive the second one down perpendicularly from the end of the first, and then nail the two ends together; and that would keep all steady.

After having got every thing ready, the boys waited till the evening before fixing up the dial, because they could not see the North Star in the day time. But when the evening came, they went out, and began their preparations. It was a clear and pretty cold evening, and the stars were out in thousands.

"Which is the North Star?" asked Rollo.

Jonas looked about a minute or two, saying, "Let me see — where's the Dipper? O, I see a part of it; the rest is down behind the barn. It was up high the last time I saw it."

"Where is the Dipper?" said Rollo, looking eagerly in the direction to which Jonas was turned.

"Come this way," said Jonas, "so as to be out of the way of the barn, and you can see it better."

So Jonas pointed out the Dipper to Rollo, with its square body, and long, bent handle. It was at first quite difficult for Rollo to see any thing that looked at all like a dipper; as it consisted only of stars, which it required some imagination to make look like one.

"The handle reaches almost down to the ground," said Rollo.

"Down to the horizon, you mean," said Jonas.

"Is that the horizon?" said Rollo.

"Yes," said Jonas, "where the earth and sky meet. Not long ago the Dipper handle was away up there," he continued, pointing up very high.

"Does the Dipper move?" said Rollo.

"Yes, it goes round and round the North Star, all the time. All the stars that are near the North Star keep going round and round it, once every day."

"And the rest of the stars," said Rollo, "do they go round too?"

"Yes," said Jonas; "only they are so far from the North Star, that they go in larger circles, and so go down below the horizon, and are out of sight sometimes. They come up in the east, like the sun, and go over and down in the west. But they don't go over straight," he added. "They don't come right up straight, and so go directly over. They slant away, off to the south, so as to keep always just so far from the North Star."

"That's curious," said Rollo.

"I think it is," said Jonas. "And they all go together; they don't move about among themselves, at all."

"Don't they?" said Rollo.

"No," said Jonas; "only there are a few wandering stars, that keep wandering about among the others. But the rest all keep

exactly in their places, and all go round together ; so they are called *fixed* stars."

"Show me one of the wandering stars," said Rollo.

"I don't know which they are," said Jonas, "only they are pretty bright ones."

"I guess that's one," said Rollo, pointing to a pretty bright star in the east.

"Perhaps it is," said Jonas.

"I wish I knew," said Rollo.

"I'll tell you how you can find out," said Jonas.

"How?" asked Rollo.

"Why, when you go into the house, take a piece of paper, and go to the window, and make some dots upon it, for all the stars around that one. Make the dots just in the places that the stars seem to be in. Then let them all go. They will rise more and more, and go overhead, and down in the west, and to-morrow night they will come up in the east again ; and then you can look at them again, and see if the bright star has changed its place at all."

Rollo said that he meant to do that ; and then he said that he began to feel cold, and

wanted to go in. But Jonas told him that he ought to wait and help finish the dial.

So they went to the place which Jonas had selected, and Jonas, looking up first at the North Star, made a hole in the ground, with an iron bar, in an oblique direction, so that the bar should point pretty nearly to the North Star. Then he drove in one of his stakes in the same way. He then made a hole, perpendicularly, directly under the end of this inclined stake, and drove the other stake down into that. The two upper ends of the stakes were now together.

Then Jonas stooped down, so as to bring his eye near the edge of the inclined stake, at the lower end, so that he could "*sight*" along the edge of it, towards the star. He had previously cut a notch in it, so that he could get his eye down far enough to look directly along the edge. At the same time, Rollo took hold of the upper end, and stood ready to move it either way, as Jonas might direct, until it should point exactly towards the North Star.

"Down," said Jonas.

Then Rollo moved it a little down.

"Down more."

Rollo moved it farther.

“Up — up a little,” added Jonas. “There — that will do. Now hold the two stakes firmly together, exactly so.”

Then Jonas took some nails, which he had before provided, and nailed the tops of the stakes together, Rollo holding the axe up against them, on the opposite side. This supported the end of the inclined stake firmly, so that it could not move up or down. This was all that the boys wanted to do in the evening, and so they both went in.

The next day, Jonas sawed off the ends of both stakes where they projected beyond the junction; and then Rollo said he would watch the clock all day, and mark the place where the shadow came each hour, and drive a little stake down. “Then,” said he, “our dial will be done.”

“But what do you suppose is the reason,” said Rollo, “that we must make it point to the North Star more than to any other?”

“I don’t know,” said Jonas, “unless it is because the North Star is the only one that keeps always in the same place. The rest move round and round every day. Those that are far enough from the North Star to go

down below the horizon, rise and set ; and those that are not far enough, go round and round in circles, in the open sky. But the North Star keeps still."

"Does it?" said Rollo, turning around, and looking up to the part of the heavens where he had seen the star the evening before.

"Yes," said Jonas ; "and the reason why we cannot see it now, is the bright daylight. It is up there now, just where it was last night."

"And the Dipper, too?" said Rollo.

"Yes, and the Dipper, too ; only that has moved half round, I suppose, and is now away up above the North Star."

"I wish I could see it," said Rollo. And he looked as steadily and intently into the clear blue sky, as he could ; but he could not possibly see the least sign of a star.

However, the sun shone bright, and it cast a strong shadow from the stakes which they had driven into the ground. Jonas soon went away to his work, and left Rollo to mark the hours by means of the clock.

So Rollo had to go into the house very often to see what time it was ; and at last

his father, who was sitting there at his writing, asked him what made him want to see the clock so much. Rollo told him the reason. So his father put down his pen, and came out to see the dial.

When he saw the two stakes, with their lower ends driven into the ground, and the upper ends nailed firmly together, he looked at them with a smile, but did not say any thing.

"Will that do?" said Rollo, looking up very eagerly into his father's face.

His father did not answer, but continued to examine the work on all sides, with a countenance expressive of curiosity and pleasure.

"It points to the North Star, exactly," added Rollo. "Jonas *sighted* it."

"Yes," said his father; "I think that will do; you have got quite a respectable *gnomon*."

"Gnomon?" said Rollo.

"Yes," said his father; "we call such a thing a gnomon. In common dials, they are made of brass; but I don't see why this won't do very well. It is rather a *large* gnomon."

"Is it?" said Rollo.

"Yes," said his father, "I think it is the biggest gnomon I ever saw.

"But how are you going to mark the hour lines, Rollo?" asked his father.

"Why, we are going to drive little stakes down into the ground."

"'Seems to me that you can contrive some better plan than that," said his father.

"Why?" said Rollo. "Is not that a good plan?"

"Not very good," he replied; "because you cannot be exact in driving down stakes. The beauty of a dial is its exactness. I should think that you would do better to put a board down upon the ground, and mark your lines upon that."

"O, the board would get knocked about," said Rollo.

"I dare say that Jonas would contrive some way to keep it steady."

"But he says he can't do any thing more about the dial to-day, for he must attend to his work."

"Let me see — he is putting the harnesses in order, I believe."

"Yes, sir," said Rollo.

“ Well, you may tell him that after he has done the harness, that he is at work upon now, he may finish his dial.”

Then Rollo's father went into the house, and away went Rollo in pursuit of Jonas.

Jonas liked the plan of putting a board down very much, and in a short time he went to work to do it. He planed out a board of the right length, and then put it down upon the ground, under and between the two stakes, but nearest to the upright one. They placed it across at right angles to the line between the stakes, and of course, as the stakes were in a north and south line, the board was in an east and west line, and so the shadows were cast exactly across it.

The board being planed smooth, the edge of the shadow could be seen much more distinctly upon it, than upon the ground ; so Jonas was satisfied that it would be a great deal better to draw the hour lines upon the board. After having determined upon the place where it was to go, he took it up again, and then drove down two strong but short stakes, sawed off square at the top, into the ground, one on each side ; so that they should come under the two ends of the





board. Then he laid the board down again upon the stakes, and nailed the ends of the board to them. The stakes had been driven in until they were just level with the surface of the ground, and so the board seemed to be lying along upon the ground too, though it was, in fact, fastened securely to the short stakes. Then the boys marked the hour lines upon the board with some black paint; and thus they had a very respectable dial. When the sun shone, Rollo could tell what o'clock it was near enough for all his purposes.

THE BEE-HIVE.

ONE of the drollest of all of Rollo's experiments was his plan for getting a bee-hive.

One day, he was in the garden with a playmate of his, named Henry, who lived not very far from his father's house.

In the back part of the garden were some tall hollyhocks growing. They were in full flower. Hollyhocks are very tall. They grow up in a straight stem, as high as a man's head, with leaves and flowers from top to bottom.

The flowers are large, and shaped somewhat like a cup, or rather a wine-glass, and bees often go into them to get honey.

Now it happened that as Rollo and Henry were sauntering about, near these hollyhocks, Rollo happened to see a bee in one of the flowers, loading himself up with wax or honey. The flower, that the bee was in, was just about as high as Rollo's head.

"O, there's a bee!" said Rollo; "let's catch him."

"Catch him!" said Henry. "If you do, you'll catch a sting, I rather think."

"No," said Rollo, "I can catch him without getting stung."

"How?" said Henry.

"I will show you," said Rollo.

So saying, Rollo approached the hollyhocks, and put both his hands up slowly to the flower which the bee was in. He then very carefully gathered together the edges of the flower, so as to enclose and imprison the bee. He then gently broke off the stem of the flower, and held it up to Henry's ear, to let him hear the bee buzz within.

"Now," said Rollo, "I wish I had a little bee-hive. I would put him in, and perhaps he would make some honey in there."

"Do you think he would?" said Henry.

"Yes," replied Rollo, "I have no doubt he would; bees always make honey in bee-hives."

"Haven't you got some box that will do?" said Henry.

"I don't know," said Rollo; "let us go along towards the barn, and see if we can't

find one. I suppose it is no matter what the shape of it is," he added, "if it is only a box, with a small hole for the bees to go in and out."

"But you haven't got but one bee," said Henry, as they walked along towards the barn.

Rollo held the flower, with the bee imprisoned in it, safely in his fingers.

"O, I can catch plenty more. I could catch a whole hive of them, in time."

"But I don't believe they will stay and work in your hive," said Henry. "They will all fly off and go home to where they belong."

"No," said Rollo, "I will plug up the hole, and keep them shut in until they get used to it. When they get wonted to the new hive, they will stay there, after that, I know. That's the way they do with doves."

"But you won't have any queen bee," said Henry. "Bees won't work without a queen bee. I read it in a book."

"Well, perhaps I can catch a queen bee, some day," said Rollo, rather doubtfully.

Rollo was so much interested in his plan,

that he was determined not to see any difficulties in the way of it ; and yet he could not help feeling that there was some uncertainty about his succeeding in entrapping a queen bee.

However, just at this point in the conversation, he suddenly stopped, and pointed down to a flower-pot, which stood bottom upwards, upon a seat, near where they were walking.

"There," said he, "that will do for a bee-hive."

"Ho!" said Henry, "that is not a box."

"No matter," said Rollo ; "it is just as good, and there is a little hole for the bees to go out and in at."

There is always a little hole in the bottom of a flower-pot.

"So there is," said Henry ; "but do you think that the bees will make honey in an earthen pot?"

"O, yes," said Rollo, "just as well as in any thing. The bees don't care what they make the honey in. Sometimes they make it in old logs."

"Well," said Henry, "and we'll call it a honey-pot. And where shall we put it?"

"We can keep it on this seat: it is as

good a place as any ; the bees will be right in the garden as soon as they come out of their hive."

So saying, Rollo asked Henry to hold his bee a minute, while he got the honey-pot ready. Henry took the flower very carefully, so as not to let the bee escape, and then Rollo lifted up the flower-pot, and looked inside. It was pretty clean ; but as Rollo knew that bees were very nice in their habits, he thought he would just take it to the pump, and wash it out a little.

In a few minutes, he brought it back, and replaced it, bottom upwards, upon the seat, and then prepared to put the bee in. He took the flower again from Henry's hand, and then very carefully inserted the edges of it, which had been gathered together with his fingers, into the hole. He then began to knock and push the bottom of the flower, to make the bee go in. The bee, not knowing what to make of this treatment, kept up a great buzzing, but soon went in.

"There," said Rollo. "Now, Henry, you be ready to clap your thumb over the hole, as soon as I take the flower away, or else he'll come out."

"O, no," said Henry; "he'll fly up and sting me."

"No, he won't," said Rollo. "I only want you to keep him in a minute, while I go and get a plug."

Henry then, with much hesitation and fear, put his thumb over the hole, as Rollo withdrew the flower. He stood there while Rollo went for a plug; but he seemed to feel very uneasy, and continually called Rollo to be quick.

Rollo could not find a plug, but he picked up a small, flat stone, and concluded that that would do just as well. So he released Henry from his dangerous position, and put the stone over the hole.

"There," said Rollo, with a tone of great satisfaction, when he had done this, "now he is safe. We'll let him stay, while we go and catch another bee."

So they went back to the hollyhocks, and there, quite fortunately, they found another bee just going into one of the flowers. Rollo secured him in the same way, and carried him along, and pushed him into the flower-pot. Henry stood ready to clap the stone on, as soon as he was in, and then they

came back to the hollyhocks again. They had then to wait a little while, watching for bees ; at length, however, one came, and, by and by, another ; and so, in the course of an hour or two, they got seven bees, all safe in the honey-pot, and Rollo said he thought seven were about enough to go to work, at least, to begin. They had not yet found any one, however, that seemed to Rollo to be a queen bee.

At last, it was time for Henry to go home, and Rollo concluded to leave his bee-hive until the next morning. He thought he would leave the hole stopped up, so that the bees might get used to their new accommodations ; but he intended to open it the next day, in order to let them begin their work.

The next morning, Henry came over soon after breakfast to see how affairs stood in respect to the bee-hive. He and Rollo went out into the garden to look at the establishment, and found every thing as they had left it the night before. Rollo felt quite confident of the success of his experiment. The only thing that gave him any uneasiness was the want of a queen bee. He and Henry were just speculating upon the expe-

diency of sending in a bumble-bee instead, for a king, when their attention was arrested by hearing Jonas calling Rollo. They looked up, and saw him standing at the garden gate.

"Rollo," said Jonas, "do you want to go out with me to the pasture, and catch the horse?"

"Why, — yes," said Rollo. But yet he did not go. He seemed to feel in doubt. "Must you go this minute?" said he.

"Yes," said Jonas. "Come; and Henry may go, too."

"Well, wait a minute, just till I go and open the door in my bee-hive."

"Your bee-hive!" said Jonas; "what do you mean by that?"

But Rollo did not hear what Jonas said; for he had run off along the alley, Henry after him, towards the place where they had established their hive.

"What does he mean by his bee-hive?" said Jonas to himself. "I mean to go and see."

So Jonas opened the garden gate, and came in. When he came up near the seat where Henry and Rollo stood, he found the boys

standing a step or two back from the flower-pot, both watching the hole with the utmost intentness.

“What are you looking at there, boys?” said Jonas, with great surprise.

“O, we are looking to see the bees come out.”

“The bees come out!” said Jonas.

“Yes,” said Rollo; “that is our bee-hive, — honey-pot we call it. We have put some bees in it.”

Here Jonas burst into a loud, and long, and apparently incontrollable fit of laughter. Henry and Rollo looked upon him with an expression of ludicrous gravity and perplexity.

“What are you laughing at?” said Rollo.

Jonas could hardly control himself sufficiently to speak; but presently he succeeded in asking Rollo if he supposed that bees would make honey there.

“Certainly I do,” said Rollo, with a positive air. “Why should they not? They don’t care what shape their hive is, or what it is made of, and this flower-pot is as good as any thing else. There! there! see, Henry,” he exclaimed, interrupting himself,

and pointing down to the flower-pot, "one is coming out."

Henry and Jonas both looked, and they saw a poor, forlorn-looking bee cautiously putting forth his head at the hole, and then slowly crawling out. He came on until he was fairly out of the hole, and then, extending his wings, rose and flew away through the air.

Here Jonas burst out again in a fit of laughter.

"You needn't laugh, Jonas," said Rollo; "he'll come back again; I know he will. That's the way they always do."

"And you suppose that the bees will fill up the flower-pot with honey?" said Jonas.

"Yes," said Rollo; "and then I shall take it away without killing any of the bees. I read how to do it in a book."

"How shall you do it?" said Jonas.

"Why, when this honey-pot is full of honey, I shall get another, and put on the top of it, bottom upwards. Then the bees will work up into that, and come out at the upper hole. When they get fairly at work in the upper hive, then I shall get Henry to

hold it, while I slip the lower one out, and put the upper one down in its place."

As Rollo was speaking these words, in order to show Jonas more exactly how he meant to perform the operation, he took hold of the flower-pot with both his hands, and slid it suddenly off of the seat. Now it happened that the poor bees that were inside, chilled with the dampness and cold, were nearly all crawling about upon the seat; and when Rollo suddenly moved the flower-pot along, forgetting for a moment what there was inside, the rough edges of the flower-pot bruised and ground them to death, and they dropped down upon the walk, some dead, some buzzing a little, and one trying to crawl.

"There now, Rollo," said Henry, in a tone of great disappointment and sorrow, "now you have killed all our bees!"

Rollo looked astonished enough. He had no idea of such a catastrophe; and he and Henry both at the same instant took up the honey-pot to see if any of the bees had escaped destruction. Their eyes fell at the





same moment, upon one solitary bee that was standing upon the inside of the flower-pot. His attention had been arrested by the sudden glare of light, and so, just as Rollo and Henry first observed him, and before they had time to put the flower-pot down again, he spread his wings and flew out towards them.

Down dropped the flower-pot. The boys started. "Run!" exclaimed Jonas, following them with shouts of laughter, "run, run, boys, for dear life!" and away they all went towards the garden gate.

The bee, however, was not following them. His only object was to get away. He flew in another direction; but Rollo, Henry, and Jonas did not stop to look behind them. They kept on running, until Jonas was well on his way towards the pasture, and Rollo and Henry were safe in the shed. And this was the last time that Rollo ever attempted to *make up* a hive of bees.

JONAS'S MAGNET.

ONE evening, after tea, Rollo was seated upon his cricket, before the fire, reading. His mother was upon the sofa, also reading, and so the room was very still.

By and by, Rollo finished his book. It was quite a small story-book, and he had been reading it some time, and so he had got to the end. He laid the book down, therefore, upon the table, and began to consider what he should do next.

"Mother," said Rollo, "what shall I do?"

"I don't know," said his mother; "you must contrive some way to amuse yourself, for I am busy reading, now."

Rollo sat still, looking at the fire a few minutes, and then he thought he would go out into the kitchen, and see what Nathan was about. Accordingly, he went into the kitchen. Dorothy was at work, making some bread for the next day. Jonas was bringing in wood. Nathan was sitting upon

the floor before the fire, very much interested in looking at something which he held in his hand.

"What have you got, Nathan?" said Rollo.

"I am seeing this nail stick on," said Nathan.

"Stick on!" said Rollo; "what does the child mean?" He accordingly came up to Nathan, and found that he had a smooth, flat bar of steel, not very regular in its shape, in one hand, and a nail in the other; and he was amusing himself with applying the nail to the bar of steel, and seeing it adhere.

"It is a magnet," said Rollo. "What a big magnet! Where did you get it, Nathan?"

"Jonas gave it to me," said Nathan.

"Let me try it," said Rollo. And he stooped down by the side of Nathan, and offered to take away the magnet.

But Nathan held it off upon one side, and said, "No, no; I must have it. Jonas gave it to me."

"Well, Thanny," said Rollo, "I won't take it away; only you let me sit here and see you play with it."

So Rollo sat still, and did not molest Nathan, but only looked on and saw him touch the little nail to the bar, and leave it hanging there. Rollo knew it was a magnet, for he had heard of magnets, though he had never before had an opportunity of seeing one. As Nathan found that Rollo was not going to take the magnet away from him, he soon ceased to appear afraid of him, and presently he let Rollo have the magnet in his hands. Rollo said he only wanted to look at it a moment, to see what made the nail stick on.

He examined the steel bar carefully. It was not quite a foot long, and was shaped like a common flat ruler ; only, instead of being straight from end to end, it was swelled out a little along in the middle. On looking at the bar very attentively, Rollo observed some very fine, hair-like lines, crossing each other, so as to produce the appearance of fine net-work. Rollo supposed that this was what caused the magnet to take up the nail. He observed that there was one place, near the middle of the bar, where this net-work was more distinct and strong than in the other parts of the bar, and so he put the nail there, expecting that it would be

attracted very strongly. But he was surprised at observing that it was not attracted there at all. He then tried it at different places, all along the bar; and he found that it was not attracted any where in the middle, but only at the two ends.

While he was wondering what could be the cause of this, he heard the front door open, and he knew that his father had come home. So he jumped up and ran off into the entry, Nathan following him, to show his father the magnet. His father was busy putting away his coat and hat, and told the boys to go into the parlor, and he would come in, in a moment, and see it. When he came in, he sat down before the fire, and took the magnet, Rollo and Nathan standing by his side, and looking on with eager curiosity.

Rollo's father examined the magnet from end to end, very carefully, for some time, without speaking. At length, he said,

"It is an old file."

"An old file!" said Rollo.

"Yes," said his father. "Some of Jonas's work, I suppose."

"Yes, sir," replied Rollo; "at least it is Jonas's magnet."

"There you see the marks," continued his father, pointing to the net-work, "of the old file teeth. Jonas ground them nearly out."

"Are those the marks of the file teeth?" said Rollo. "I thought it was the magnetism."

"No," said his father, smiling, "those are the traces of the file teeth, undoubtedly. You may go and ask Jonas how he got his magnet."

So away went Rollo and Nathan in pursuit of Jonas. They found him in the kitchen, just arranging his wood for the morning fires. They asked him where he got his magnet, and Jonas replied as follows:—

"Why, the other day, I went into town with your father's watch, to get a new crystal put in; and when I was at the watch-maker's, I saw a curious-shaped piece of iron hanging up. I asked the man what it was. He said it was a magnet, that he kept to touch needles. Then he gave me a nail, and let me see how the magnet would attract it. He told me, too, that if I had a knife,

and would rub my knife on the magnet, the knife would attract, too ; and so I did rub it, and I found that my knife would attract the nail, though not very strong. Then I asked him if any piece of iron would attract, after it was rubbed upon the magnet ; and he said that *iron* would not, but that any piece of *steel* would. He told me that if I would bring a larger piece of steel, when I came after the watch, he would rub it for me, and then I should have a larger magnet. I told him I had not any steel. But he said any old file would do, and that I might grind the sides and edges a little, and make it smooth.

“So, when I came home, I found some old files in the barn. Some were three-cornered, and some were flat. I thought the flat would be the best shape, and I asked your father if he would give me one of them. He said he would ; and so I ground the ends square, and the sides smooth, upon the grindstone. Then, when I went after the watch, the man rubbed it for me, and it makes a very good magnet.”

Then Rollo and Nathan went back, and repeated this story to their father.

"Very well," said their father; "that was a very good way to get a magnet. I remember giving Jonas the file; but I did not know what he wanted it for."

"I think a magnet is a very curious thing," said Rollo. "See how the nail sticks to it!"

"There are a great many other things curious about it," said his father, "besides that."

"What?" said Rollo.

"I should want some other apparatus to show you," replied his father.

"And can't you get the other apparatus?"

"I don't know. Perhaps mother might get it. Yes, I'll tell you what we will do. I will name some things which mother may prepare, and you may get them together upon the table in the kitchen, when they have got the kitchen all in order. Then I will come out, and give you all, out there, a lecture upon magnetism."

Rollo and Nathan were exceedingly pleased with this plan; and even Rollo's mother looked somewhat gratified. She said she did not know much about magnetism,

and she meant to go out into the kitchen herself, and hear the lecture.

“And what things shall we get?” said Rollo.

“Two or three needles,” replied his father, “some fine, and some coarse; some thread, a saucer nearly full of water, a cork, the sand-box off of my table, and a sheet of white paper. Put them all in good order upon the table, and set the chairs around it. Then, when all is ready, come and tell me.”

So Rollo's mother put down her book and went to help Rollo collect the articles which his father had said he should require. She began to look into her needle book for the needles and thread, while Rollo went for the sand-box. When Rollo came back with the sand-box and the sheet of paper in his hand, he found Nathan with his high chair, at the kitchen door, trying to get in.

“What are you doing here, Nathan?” said Rollo.

“I want to get my high chair in,” he replied.

The truth was, that Nathan, having learned from the conversation what was going on, was eager to secure a good seat for himself,

and so he was attempting to drag out the high chair which was kept in the parlor for him to sit up to the table in.

Rollo, as he happened to feel rather good-natured than otherwise, just then, after putting down his things, helped Nathan get his chair through the door, and placed it up at the kitchen table, which stood out in the middle of the floor. He then went into a closet, and opened a little drawer, where he knew corks were kept, and brought out one or two, selecting the cleanest and softest that he could find. When he came back, he found Nathan pouring out some black sand, from the sand-box, upon the sheet of paper.

"Now, Nathan," exclaimed Rollo, running up to him, and seizing the sand-box, "you are a very naughty boy." And he attempted to take away the sand-box violently.

But Nathan, though he knew very well that he was doing wrong, did not seem fully disposed to admit Rollo's authority to set him right by violence. He resisted; and, in the struggle, the table was pushed away, and the water in the saucer spilled over. The water ran along under the sheet of paper. Nathan, seeing the mischief that had

been done, was a little frightened, and released his hold. Rollo then took up the paper, which had sand upon the upper side, and water dripping off from the under side, saying,

"There, Nathan, now see what you have done !"

"I didn't do it," said Nathan.

"You did," said Rollo.

"I didn't," said Nathan.

Hereupon, Jonas came up to the table to see what was the matter. Each of the boys told his story.

"Now we are in pretty trouble," said Jonas ; "we thought we were going to have a fine lecture ; instead of that, there are two boys to be punished, and wet paper to be dried."

"Punished ?" said Rollo.

"Yes," said Jonas, "Nathan for touching the sand-box, and you for touching *him*."

"Why, he was pouring out all the sand," said Rollo, "and I was only trying to stop him."

"Yes, but you know," said Jonas, "that you had no right to stop him by violence. That always makes the difficulty worse."

Here Rollo began to look pretty sober. He knew that he had done what he had very often been forbidden to do.

"Now," said Jonas, "we can wait and tell your mother about it, when she comes out, or we can just settle it all among ourselves."

"How?" said Rollo, with an anxious look.

"Why, I can dry the paper and the sand," said Jonas, "if you and Nathan will only punish the boys."

"How shall we do it?" asked Rollo, looking up with a faint and doubtful smile.

"I think a pretty good punishment," said Jonas, "would be for you and Nathan to go and sit in two corners of the room, with your faces to the wall, until I get the paper and sand dry — if you think that would be punishment enough."

"Well," said Rollo, — his eye brightening at the idea of winding up so unpleasant a business so easily, — "well, Nathan, let's go."

Nathan was ready, and so he climbed down from his high chair, and as Rollo went to one corner of the room, he went to the

other, and they took their places, as Jonas had directed ; only Nathan could not resist the temptation of looking round, now and then, to see how Jonas got on with the drying of the paper. They, however, bore their self-inflicted punishment very patiently ; and when Jonas had got the paper dried, and the table wiped down, and every thing replaced as it was before, he told them that it was time for them to get up again. The punishment was not very severe, it is true ; but then, it was probably a pretty efficacious one, in respect to its effect in impressing it upon Nathan's mind that he must not touch things without leave, and upon Rollo's, that, when Nathan is doing wrong, he must not set him right by violence.

In a short time after this, the things were all ready upon the table, the chairs were placed around it, and Rollo went to call his father. He found him writing a letter. As soon as he reached the end of a sentence, he came out, and took his place at the table. Rollo's mother sat next to him at the same side of the table, and Jonas and Dorothy in two chairs, on the opposite side. Rollo

then was placed at one end of the table, and Nathan, in his high chair, at the other.

Just then, however, Rollo's mother observed that the table was wet a little.

"Why, Rollo," said she, "how came the table wet?"

"Why, Nathan and I did it," said he.

"How?" said his mother.

"Why, we did it — eh — pulling. But Jonas has settled it all, mother."

"Ah! Jonas has settled it, has he? very well. Then we will all now attend to the lecture."

MAGNETISM

ROLLO's father looked over the things which had been arranged upon the table, for a moment, in silence, and then took up Jonas's magnet.

"This bar is what they call a magnet," said he; "but all the magnetism is in the two ends."

"It is?" said Rollo; "and what is the reason of that?"

"You can see that it is so," said his father, without answering Rollo's question, "in this way."

So he laid a small nail down upon the table, and then touched the middle of the magnet to the nail. It was not attracted at all. Then he moved it along a little, towards one end, and touched it again. Still it was not attracted. Then he moved it along farther and farther; but the nail was not attracted until he got to the end of the

bar, and then the nail hopped up and adhered to it quite strongly.

“How curious!” said Rollo.

His father then repeated the same experiment with the other half of the bar, and found the result the same. The nail did not appear to be at all attracted until he reached the end, and then it was lifted and held by this end, just as it was by the other.

“So that, you see,” said Rollo’s father, “that the attractive power of the magnet resides in the ends.”

“Well, father, what is the reason?”

“I don’t know,” said his father.

“Don’t you know, father?” said Rollo. “I thought you were going to tell us all about it.”

“No,” said his father. “I only know a very little about it, myself. I am going to explain to you some of the facts, — such as I happen to know. So you must all remember this fact, that in the magnet, the attractive power is not distributed over the whole mass, but resides only in the opposite ends. These ends are called *poles*.”

“Yes, sir,” said Rollo, “we will remember.”

"Now I can make this apparent in another way," said his father. Then he asked Rollo's mother to thread a needle ; and when it was threaded, he asked Jonas to stand up and hold the thread in such a manner as to let the needle hang over the middle of the table.

Then, when the needle was still, he brought up the middle of the magnet very near to the needle ; but it did not move towards it at all. Then he drew the magnet along towards himself, keeping it at the same distance from the needle, and when the end of the bar came opposite to the needle, it immediately leaped out of its place, and adhered strongly to it.

"There is another way still," continued the lecturer, "better than either of these."

So saying, he took off the needle, which had adhered to the magnet, and drawing out the thread, he laid the needle itself carefully away upon a distant corner of the table. Rollo took it up, and was going to place it back with the others. But his father told him to put it down again, by itself, where he had placed it, and not to touch any of the things without his direction.

“I am going to show you another way,” he added, “of making it evident that the attractive power of the magnet resides at or near the poles.”

So saying, he opened the sheet of paper, and spread it out upon the table. Then he laid the magnet down upon it.

“Now, Jonas,” said he, “sprinkle some sand upon it from my sand-box, carefully, and see where the sand will adhere.”

So Jonas took the sand-box, and held it over the bar, not very high, and moved it slowly along, from one end to the other, and thus sanded the magnet all over. The sand fell off of it, however, freely, at every part except the ends; and Jonas, observing that it seemed to adhere there, held the sand-box a little longer over those places; and thus there was formed a sort of a black bur at the extremities, consisting of an accumulation of the black particles of sand. Rollo's father then took up the bar carefully, and passed it around, so that all who were seated at the table could examine it closely.

“It is thickest on all the edges and corners,” said Rollo.

“Yes,” said his mother; “and the sand

forms little black bristles, pointing off in every direction."

They all examined it attentively, and observed the little black bristles pointing out every way from the edges and corners at the ends.

"This shows you," said Rollo's father, "exactly how the magnetic power, so far as its attractive force on other bodies is concerned, is distributed. You see it resides in the two ends, and the two ends seem to be exactly alike."

"Yes, sir," said Rollo, "exactly."

"They *seem* to be so," continued his father; "but the fact is, the magnetism of one end is very different from that of the other."

"I see that the cluster of sand is a little bigger at one end, than it is at the other," said Rollo's mother. She was more observing than the others, and had noticed a little difference, which had escaped the rest.

"That indicates only a difference in degree," said Rollo's father; "but there is a difference in *kind*."

"What do you mean by that, father?" asked Rollo.

"Why, if the attractive powers at the two

ends were both alike in their nature, only one was stronger than the other, then the difference would be in *degree*; but there is a difference in the nature of the magnetism itself. In fact, the magnetisms of the two ends are of opposite natures in some respects."

"Why, both ends attract the sand," said Rollo, "just alike."

"True," said his father; "they seem to attract the sand in precisely the same way; and, looking at the bar, as I now hold it up," he added, "with the sand adhering in the same way at the two ends, one would suppose that they were both magnetic alike. But, in fact, there is a great difference between them."

All the company looked upon the two ends of the bar, as Rollo's father held it up, wondering how he would show that there was any difference between them.

"Now, in the first place," he continued, "we must get the sand off of the ends. Do you think you can get it off for me, Rollo?" said he.

Rollo took the bar very eagerly, and attempted to brush the sand back upon the paper. He succeeded in brushing off a

little of it; but the greater portion remained. When he rubbed upon one side, it moved round to the other; and he could not get it off.

“Hand it to me,” said his father, “and I will show you how it can be done.”

He also asked Jonas to hand him the tongs, which were standing by the side of the fire. He then held the tongs over the sheet of paper, in a horizontal position, and gently rapped the end of the magnet against them, letting the end project a little over the tongs. This knocked all the sand off, and left the bar clean as it was before.

“Now let me see,” said he, “what was it that I was going to tell you next?”

“You were going to show us,” said Rollo’s mother, “that there are two different kinds of magnetisms in the two ends of the bar.”

“O, yes,” said he. “In order to do this, I must poise a needle in a new way.”

He then took up one of the corks which Rollo had put upon the table. From one end of this cork, he cut off, with his pen-knife, a round, flat piece. It was about as large around as a wafer, but somewhat thick-

er. He cut a little groove along the upper side of this, and laid the same needle which he had before used, and which he had put away upon the corner of the table, into this groove. Then he put the whole carefully into the saucer of water, which he had previously drawn up towards him.

“There,” said he, “we call a cork like that, a *float*; because it is intended to float a needle upon. Now, you see, the needle being supported by the cork, and the cork floating freely in the water, the needle is at liberty to move in any way.”

Nathan thought it was a very curious experiment to poise a needle so, upon a piece of cork,—even without the magnetism. And he watched it as it slowly moved about, with a face full of interest and curiosity.

The needle swung round a little one way and the other, and finally came to a state of rest. Then Rollo’s father held the magnet in his hands, in such a manner as to point it towards the needle, and then gradually brought it down near the water, just by the side of the point of the needle. The point immediately began to move slowly towards

the bar; but Rollo's father lifted it up suddenly, before the needle had time to touch it. Then he brought the same end of the magnet down upon the other side of the point of the needle, and that drew it back again.

"There," said he, "you all see that the point of the needle is attracted by the bar, whichever side I put it."

They all said they saw it very plainly.

"Now," said he, "I am going to turn the magnet, and bring the other end of it down to the point of the needle; and if the magnetism at this end is the same with that in the other, the point of the needle will of course be attracted by this end too."

"Certainly," said Rollo's mother.

Then he brought down the other end of the bar towards the needle. This other end was a little bigger than the one which he had tried first, because the file had been a little bigger at that end. But the needle, instead of being drawn towards it, as it had been towards the other end, began to move slowly away from it.

"Why, it is going away," said Rollo.

His father did not answer, but immediately raised the bar and put it down upon the other side of the point, and then the point began to move away back again; being evidently driven away from the large end of the magnet, on whichever side it was presented.

Then Rollo's father reversed the magnet again; that is, he brought the smaller end towards the needle as at first. The point of the needle was now attracted, that is, drawn towards the magnet; and then when he changed it again, and brought the large end to the needle, it was always *repelled*; that is, driven away again.

"Now you see," he said, "that the small end of the magnet attracts the point of the needle, and the large end drives it away. That shows that the magnetism in the two ends is of two different kinds.

"And now," he continued, "there is one thing more which is remarkable about it; and I want you to observe it very carefully. You see," he says, "that the small end of the magnet attracts the point of the needle. But if I try it now upon the other end of

the needle, where the eye is, it will *repel* that, just as the large end of the magnet repels the point."

He tried it, and the result was just as he had said. And he repeated the experiment in a great many ways, and they always found that the large end of the magnet would draw the eye of the needle towards it, and drive the point away; and the small end of the magnet would draw the point of the needle, and drive the eye away. This proved, as Rollo's father said, some great difference between the magnetisms of the two ends. "And you see," he added, "that it is a difference in *kind*, not merely a difference in *degree*."

"But one thing seems strange to me," said Rollo's mother, "and that is, that both ends of the magnet don't attract the point of the needle, just as both of them attracted the nail."

"And the sand," said Rollo.

"Yes," added his mother. "When you brought both ends of the magnet, one after the other, to the nail, they both attracted it."

“And so they did the needle which hung down by the thread,” said Jonas.

“Yes,” said Rollo’s mother; “but now this needle, that is floating upon the water, is half attracted, and half repelled.”

“The reason is,” said Rollo’s father, “that the needle, that is floating upon the water, is a magnet itself, and has two magnetic poles; but the sand, and the nail and the needle that Jonas held up by the thread, were not magnets. They were only common pieces of iron and steel.”

“Why, father,” said Rollo, “that was the very same needle; you laid it away upon the corner of the table.”

“Yes,” said his father; “but it was not a magnet *then*.”

“When?” asked Rollo.

“Why, when Jonas held it up by the thread.”

“And is it a magnet now?”

“Yes,” said his father. “We will see if it is not.”

So he took the needle off from the float, and put it upon the paper. He then sprinkled a little sand over it, from the sand-box, and,

upon taking it up, they all saw that there was a little tuft of black sand both upon the point and at the eye, showing that it was magnetic at both ends.

“It became magnetic,” said Rollo’s father, “only by being touched by the bar magnet, and that was the reason why I put it away by itself as soon as it had touched the bar. I did not want to have it mixed with the other needles, which had not been touched, and which, of course, were not magnetic. Now, if I take one of the needles which has not been touched, and put it upon the float, you will see that both ends of it will be attracted by both ends of the bar.”

So he placed away the magnetized needle upon the corner of the table again, and took another one, and placed it very carefully upon the float. Then he brought down one end of Jonas’s magnet very near the point of the needle. It attracted it. Then he brought it down very near the eye of the needle. It attracted the eye too. Then he turned the magnet, and tried the other end, and he found that that end also would attract both the eye and the point of the needle.

“Try the magnetized needle, and see if that will attract it too,” said Rollo’s mother.

Then Rollo’s father took the magnetized needle from the corner again, and brought the two ends of that, one after another, near to the ends of the needle upon the float. It attracted them just as Jonas’s magnet had done, only a great deal more feebly.

“So, you see that this needle is really a little magnet, just like Jonas’s great one.”

“Only there is no proof that it has the two different kinds of magnetism in the two ends,” said Rollo’s mother.

“We can easily show that,” said his father. He asked Dorothy to get another saucer full of water, while he prepared another float. Then he put the magnetized needle upon the new float, leaving the unmagnetized one upon the old float. They both looked almost precisely alike, each upon its own little disc of cork in its saucer of water.

“There,” said he, “you cannot see any difference between them; but there is a great deal of difference between them; for one is only a common needle of steel, but

the other has its two extremities magnetic in opposite ways."

To prove this, Rollo's father brought one end of the bar to the *point* of the magnetized needle, and the point was repelled. He brought it then to the *eye* of the same needle, and it attracted it. Then he brought the same end of the bar, first to the point, and then to the eye of the unmagnetic needle, and it attracted them both ; so it was evident that there was a considerable difference, in reality, between the condition of the two, though there was no difference in external appearance.

"Now you see, from all this," added Rollo's father, "that when a magnet touches a piece of steel, like a needle, it immediately makes it a magnet itself ; that is, it makes the two ends magnetic, one having one kind of magnetism, and the other the other kind ; and then, if you take two magnets, and bring those two poles which have the same magnetism together, they repel one another ; and if you bring those together which have different magnetisms, they attract each other."

"How do you know that they are the

same magnetisms that repel, and different that attract?" said Rollo's mother.

"I will show you," said his father.

Then he took the needles that he had used off from their floats, and laid them away. He took next two new needles, exactly of a size, and he held them together between his thumb and finger, with the eyes projecting together. Then he rubbed them once or twice upon the end of Jonas's magnet, saying,

"There, you see I use both of these needles alike. Of course the eyes have both the same magnetisms. Now you will find that when I put one of them upon the float, and then bring the eyes together, they will repel each other; but an eye and a point will attract. So two points will repel."

"But you have not magnetized the points," said Rollo's mother.

"Yes," said his father. "When we magnetize one end, the other end becomes magnetized, itself, in the contrary way."

So he put one of the needles upon the float, and then brought the eye of the other down very near to its eye. It was repelled,

as he had said it would be. He then brought the two points together, and they were repelled. But if he brought an eye towards a point, or a point towards an eye, they were attracted.

"This is the end of my lecture," said he, "for to-night."

"O, father," said Rollo, "a little more."

"No more to-night, only to recapitulate," said he.

"Recapitulate? what is that?"

"Why, tell you, briefly, the substance of what I have explained, so that you may remember it."

"Well, father," said Rollo.

"In the first place, a magnet has a peculiar and mysterious attractive power for iron, residing in its two extremities, which are called *its poles*; and the power which resides in one extremity is, in some way or other, opposite in its nature to that of the other extremity. Each of these poles repels a pole like itself, and attracts one different from itself, in any other magnet."

Poor Nathan could not understand this grave, philosophical disquisition very well,

and he began to get pretty sleepy. He had, however, been somewhat amused, during the greater part of the time, in seeing the corks float about upon the water, with the needles upon them. So his father took the needles off, and let him have the two floats in one of the saucers to play with, a few minutes, while Dorothy put the other things away. He asked her to put all the things away together, so that they could get them ready the next evening, and then he said that perhaps he would give them another lecture.

INTELLECTUAL PHILOSOPHY.

ROLLO's father gave one or two other lectures upon magnetism, in the course of which Rollo found out a good deal about the subject ; and, having learned from his father's explanations that any magnet, when balanced freely, would point to the north and south, that is, one end to the north and the other to the south, he determined to try the experiment. He accordingly poised a needle carefully upon a cork, as his father had done in his lecture, and put it in a basin of water upon the platform. But he did not succeed very well. The needle would always swing round, and turn its point towards the garden gate ; but Rollo knew very well that the garden gate was not north from the platform. He remembered that the North Star was over the barn, for he and Jonas had noticed it particularly when they had made the dial. The needle, therefore, ought to have pointed towards the barn, according to his father's

lecture ; but it would not. Rollo took up a straw, and pushed the point of the needle round, and said, "Point there ! point there, I tell you !" But all in vain. The needle would not heed either his pushing or his commands ; but, as soon as he let it go, it would immediately swing back into its old position, where it pointed towards the garden gate.

Rollo was just about giving up in despair, when he saw his sister Mary coming in from the garden gate, with a book under her arm.

"O Mary," said he, "what shall I do ? My needle won't point right."

"Why, what is the matter with it ?" said Mary.

"It will point over towards the garden," said Rollo ; "look."

So Mary came up, and looked at his needle. She saw that it was pointing towards the garden gate.

"Now I'll push it away," said Rollo, "and you will see that it comes directly back again."

So he took up his straw, and pushed the point of the needle away. The cork moved,

turning round rapidly, until at length it swung away towards one side of the basin, and then suddenly drifted up against the side, and stuck there.

"That's another plague," said Rollo. "It will run up to the side of the basin, and stick there."

"What makes it?" said Mary.

"I don't know," said Rollo.

Mary sat down upon the platform, and examined the needle and the surface of the water very carefully. She observed that the water was heaped up a little against the side of the basin, all around. She asked Rollo to observe it.

"Yes," said he, "and the needle and cork run right up that ridge of water."

"And the bubbles too," said Mary.

Mary pointed, when she said this, to several little bubbles which were adhering closely to the side of the basin, in another place.

She took up a little straw, and pushed away some of the bubbles from the side of the basin, and then gently moved them back again until they were pretty near, and observed that they would immediately rush

up against the side again. She did not understand this phenomenon, especially as the water was raised a little along the edge by the side of the basin, so that the bubbles and the needle actually appeared to rush up hill.

After examining this for some time, Mary moved the cork float, with the needle upon it, back into the middle of the basin, and then left it to itself. It slowly moved around until it pointed to the garden gate, as it had done before.

"Now what is the reason?" said Rollo; "that isn't north."

Mary looked upon it very attentively for a few minutes in silence, and then said, suddenly,

"O, I see."

"What?" said Rollo.

She did not answer, but pointed down to the platform by the side of the basin.

Rollo looked where she pointed, and saw the hammer lying there. He had had it to play with a short time before, and, when he brought the basin of water, he had laid it down by his side.

"What?" said Rollo.

"The hammer attracts the needle," replied Mary.

"The hammer?" said Rollo.

"Yes," replied Mary. "Don't you know that iron attracts the needle, and it will not point to the north if there is any iron near to draw it away?"

Rollo was just going to take the hammer up, but Mary stopped him, saying,

"Wait a moment. Let me take it away slowly, and see the effect."

So Mary told Rollo to watch the needle, while she carefully drew the hammer away.

Rollo did so. He and Mary both watched the needle. It was pointing pretty nearly toward the hammer, and when Mary gently moved the hammer away, the needle, released from the influence which the iron exerted upon it, slowly moved back towards the direction of the barn, that is, the direction of a north and south line, which is called the meridian.

"It's going back! it's going back!" said Rollo.

Mary said nothing, but watched it carefully. The needle swung beyond the direction of the meridian a little way, and then

came slowly back again. So it continued vibrating from one side to the other, though to a less and less distance every time. Finally, it came to a state of rest ; but it was not then, however, exactly in the meridian.

“What makes it swing so, back and forth?” said Rollo.

“I don’t know exactly,” said Mary. “I suppose the force that it moves with, carries it a little beyond, and then it is drawn back again, and that makes the oscillations.”

“Oscillations?” said Rollo, inquiringly.

“Yes. They call this swinging back and forth, *oscillating*; and each movement is an oscillation.”

“Is that the name of it?” said Rollo.

“Yes,” said Mary. “When you tie a little stone to a string, and hold the upper end of the string still, and let the stone swing back and forth, it makes oscillations.”

“I mean to try it,” said Rollo.

“Yes,” said Mary; “and I will help you by and by, after I have studied my philosophy lesson.”

“Your philosophy lesson?” asked Rollo. “Have you got a philosophy lesson to get?”

"Yes," said Mary, "in that great book."

So Rollo took up Mary's book, which she had laid down upon the platform near Rollo's apparatus. He found that the title of it was "Intellectual Philosophy."

"Intellectual Philosophy?" said Rollo; "and what sort of philosophy is *intellectual* philosophy?"

"It is the philosophy of the *mind*," replied Mary. "It explains to us about the thoughts and feelings of our minds."

"Are there any *experiments* in intellectual philosophy?" asked Rollo.

"Yes," said Mary, "we can try experiments in intellectual philosophy."

"What experiments?" said Rollo.

"Why, there is a question whether we always dream when we are asleep."

"*I* do," said Rollo, "every night."

"Yes, but perhaps not all night long."

"Yes, I do," said Rollo. "I have good long dreams."

"But," replied Mary, "you may dream several hours in the night, so as to remember good long dreams in the morning, and yet perhaps you might have been, for some time, perfectly sound asleep, so as not to have

any dreams in your mind at all. Some persons think we dream all the time when we are asleep, and others think we don't dream all the time. Now we might contrive some experiments to decide the question."

"How?" said Rollo.

"Why, you and I might agree to wake each other up several times, from a sound sleep, and then, if we were dreaming at that time, we should probably remember it."

"Well," said Rollo, "let us try it."

"That would be an experiment in intellectual philosophy," said Mary.

Rollo determined to try the experiment; and then he took Mary's book, and asked her where her lesson was that day. She found the place, and Rollo read a little. He could not understand it very well, and so he concluded that he would rather have Mary go and study her lesson, and then come down and help him make the experiments of oscillation.

Mary accordingly took her book and went in, and left Rollo at his play.

OSCILLATIONS

IN about an hour, Mary came down into the yard in pursuit of Rollo, in order to try the experiments which she had proposed.

When Rollo saw her coming, he left his play, and ran to meet her.

"Well, Mary," said he, "have you come to make the oscillations?"

"Yes," said Mary. "I have brought some thread for strings, and I want you to get some pebble stones—some large, and some small ones."

Rollo went for the pebble stones, while Mary looked about for a suitable place for making the experiments. In a corner of the yard there was a bench under a tree, and the branches came down pretty low. Mary thought that this would be a good place, for she could tie her strings to these branches with the pebbles hanging down below; and she and Rollo could watch the oscillations, while seated upon the bench.

Mary took her station here, and Rollo presently appeared, with the crown of his cap half filled with pebble stones. Mary said they would do finely. She poured them out upon the bench by her side, and Rollo put his cap upon his head again.

“Now, Rollo,” said she, “we will study the art of experimenting.”

“No,” said Rollo, “we are going to study oscillation.”

“Yes,” replied Mary; “the experiments are to be on oscillations; but what I want principally to teach you, is, the proper way to make experiments.”

“Well,” said Rollo.

Mary said no more, but she proceeded to tie a small pebble to the end of one of the long threads which she had brought out with her. Then she tied the other end of the thread to the branch of the tree, which was over her head. The pebble then hung down before them, so that both Rollo and herself could plainly see all its motions.

“The first thing,” said Mary, “is to get a clear idea of the nature of the oscillation, for we must know what we are experimenting about.”

So saying, Mary carefully took hold of the suspended pebble stone, and began to draw it off towards one side. She showed Rollo that, as it was confined by its string above, it must move in a curved line when she drew it away from its place, rising higher and higher the farther it was drawn away. And when she had drawn it out to a considerable distance, to one side, it was at a much higher level, than when it hung down freely in its natural position.

"Now," said Mary, "you see that if I let it go, it will descend of course as much as it can, for the earth draws it downwards."

"The earth draws it?" said Rollo.

"Yes," said Mary. "The reason why things fall is that they are attracted, or drawn down, by the earth. Now the earth draws the pebble. It *would* go straight towards it, if it could; but the string confines it, and so it can only go down in the same way that it came up; that is, by the curved line."

Mary then held one of her hands open at the place where the pebble had hung when it had been at liberty, and let go the pebble, which she had been holding with the other. It fell down in the curved line, or arc, as

Mary had said it would, until it struck her hand, and there it stopped and remained at rest.

“What did you stop it for?” said Rollo.

“So that we could see and attend to one part of the phenomenon at a time,” said Mary; “that is, the *descent* of the pebble. You see the attraction of the earth causes the pebble to go down if it can, and the confinement of the string prevents its going down in any other way than in that curve or arc. For the string keeps it always just its own length from the branch, and so that makes the curved line the arc of a circle.”

“Yes,” said Rollo, “I understand.”

Then Mary drew up the pebble once or twice more, and let Rollo see it fall against her hand. Rollo observed that it was a very regular arc.

“Now we see,” continued Mary, “that I hold my hand so as to stop the pebble stone at the lowest point to which it can go; for I hold it exactly under the point where the upper end of the string is fastened to the tree. Now I will take my hand away, and then let the pebble fall, and we will see what takes place.”

So Mary took her hand away, and let the pebble fall freely. It descended as before through the arc, and then, by the force which it acquired in moving so far, it was propelled beyond the lowest point, and ascended in another curve, upon the other side, similar to the first. When the force was expended, it came back again; and thus it swung to and fro, several times, and at length came almost to a state of rest.

"There," said Mary, "those are the oscillations we are going to experiment upon."

"Yes," said Rollo.

"And first," said Mary, "we notice that they are regular."

So she swung the pebble again; and as it moved to and fro, she counted the oscillations aloud, beating time with her hand, down and up, thus, —

"One, — two, — three, — four," &c. Rollo perceived that they were very regular.

"Now, first we will endeavor to ascertain by our experiments," said Mary, "what the *time* of the vibrations depends upon."

"Well," said Rollo.

"You see," continued Mary, "it swings back and forth with a certain degree of

rapidity. Now we want to know what this rapidity depends upon, and then we could make a pendulum so that it would oscillate faster or slower, just as we pleased."

"A pendulum?" asked Rollo.

"Yes," said Mary, "we call it a *pendulum*. Any heavy body hung in this manner, so as to swing back and forth by its weight, is called a *pendulum*. So that we are experimenting upon the oscillations of a pendulum."

"Yes," said Rollo, "I understand."

"Now the question which we are going to examine," said Mary, "is, what the rapidity of the vibrations depends upon."

"O, it depends upon the bigness of the pebble," said Rollo.

"How do you know?" said Mary.

"Why, of course, a bigger pebble will be heavier, and will fall quicker, and that will make it vibrate faster."

"That is *reasoning* about it," said Mary, "and what we want to do, now, is to *experiment*. Now, in order to decide it by experiment, we must try two pendulums, one with a small pebble, and the other with a large one."

"Very well," said Rollo, "we will ; and then we shall see that the big one will vibrate the quickest."

"Let us think, first, what other circumstances there are, that it may depend upon."

"I can't think of any thing else," said Rollo.

"Why, there is the nature of the body which we suspend. A piece of cork may oscillate differently from a piece of stone."

"Yes," said Rollo, "it will oscillate slower."

"We must not decide," said Mary, "in our own minds, before we try the experiment. We must leave our minds free to observe the facts, and wait until we make the experiment, before we come to any conclusion, or else we shall not be good experimenters."

"Why not?" said Rollo.

"Because," said Mary, "when persons make up their minds beforehand what the facts will be, they are very apt not to observe fairly. So good observers or experimenters always take care to keep their minds free and unbiassed."

"Well," said Rollo, "and what else is

there that the oscillations may depend upon?"

"The length of the string," replied Mary.

"O yes," said Rollo, "it may depend upon that."

"Let us see," continued Mary. "There are three experiments we have already proposed; a large and a small pebble; a pebble and a cork; a long and a short string; and now there is one more, — a long and short arc."

"How?" said Rollo.

"Why, if I draw up the weight, which forms the pendulum, pretty high, it will swing back and forth through a long arc. But if I move it only a little way, it will swing through only a short arc, and *that* may make a difference in the length of the vibrations."

"Well," said Rollo, "and now let us try."

"First, let us see whether we have got all the apparatus we want. Here are strings and pebbles, — only we want a cork."

"I'll go and get one," said Rollo.

So Rollo went off towards the house to get the cork. In a few minutes he came back, saying,

"I have got the cork. Now how shall we begin?"

"First," replied Mary, "we will try what effect the weight of the pebble will have upon the oscillations."

"Very well," said Rollo.

"Now, in order to test that," added Mary, "we must take two pebble stones, of different sizes, and hang them together, by strings of the same kind, and of the same length; and then we must set them a-going exactly together, and then watch the oscillations. You see that as they will be alike in every respect, excepting the size of the pebble stones, whatever difference there is in the mode of vibration will probably be caused by the difference in the size of the stones."

"Is that the way they do it?" said Rollo.

"Yes," replied Mary. "Whenever we want to know what effect any one circumstance produces, in such a case, we always arrange two experiments, making them very different in respect to the circumstance which we wish to examine, and as nearly alike as possible in all other respects."

"I think that is a very good way," said Rollo.

"Yes," replied Mary, "I think it is an excellent way."

While Mary was thus explaining her plan to Rollo, she was going on steadily with preparations, Rollo standing all the time by her side, looking on with great interest. Mary selected two pebbles. One was as big as a walnut, and the other about as big as an egg. She tied two of her threads to these stones, one to each, and then tied the other ends of these threads to a small branch of the tree which extended horizontally over their heads. They hung down about two feet. She took care so to adjust the strings, as to have the centres of the stones as nearly as possible on a level.

"The big one is twice as large, and so it will go twice as fast," said Rollo.

"We shall see," said Mary.

She then drew them both carefully out a little way on one side, and holding them there steadily a moment, she let them go. They immediately began to swing back and forth, together.

After a few oscillations, however, the large stone began to gain a little upon the other, and seemed to be moving faster. Presently it had gained half an oscillation, i. e. when the large one was moving forward, the small one would be coming back.

"The big one moves the fastest," said Rollo.

"Not much," said Mary.

"No," said Rollo, "not much."

"And I don't think it is owing to the difference in the bigness of the stones."

"What else can it be?" said Rollo. "They are exactly alike in all other respects."

"Not exactly," said Mary. "We have made them as nearly alike as we could, but not exactly. There may be a good many little differences that we do not observe. But if the size of the stone would cause any difference in the vibrations, I should think it would make a much greater difference, for one is twice as big as the other."

"Let us try a *very* big stone," said Rollo,

"Well," said Mary.

So Rollo got a stone as large as an orange, which was as heavy a one as Mary thought the thread would hold; and Mary suspended that from the branch of the tree, and then swung it in company with the two others. They all went very nearly together at first, though there was evidently a slight difference, which, in a short time, separated the

oscillations, so that the stones did not keep together; while yet they each swung back and forth, in nearly the same time. Rollo and Mary both concluded, from the result of this experiment, that the size of the vibrating body did not perceptibly affect the rapidity of the vibrations.

"Now," said Mary, "we will try different lengths of string."

So she began to look over Rollo's pebbles, to find two as nearly as possible alike.

"The pebble stones must be of the same size, this time, for we want the two pendulums to be alike in all respects, except the length of the string, for that is the circumstance which we are now going to consider. We will have one string twice as long as the other."

Mary found two pebbles very nearly equal in size, and similar in shape. She tied them to two strings, making one string twice as long as the other. She suspended them as before, and then, taking hold of one with one hand, and the other with the other, she drew them out to the same distance on one side, and let them go. The short one began at once to swing back and forth very

quick, while the other followed quite slowly.

"That makes a difference," said Rollo, clapping his hands.

"It goes twice as fast," said Mary.

"More than twice as fast," said Rollo, "I think."

"Let us see," said Mary.

They set them vibrating again; but they did not succeed in ascertaining whether the short one went more or less than twice as fast as the other. The two motions, so rapid and so near together, confused them. At length, Mary proposed that Rollo should count the vibrations of the long pendulum, while she counted those of the short one, and when she had got up to twenty, she said they would both stop, and then Rollo could tell how many he had got in the same time. But this plan, though apparently a very simple one, they found it somewhat difficult to put into practice. Mary's pendulum puzzled Rollo's counting, and Rollo, who could not count very well without at least whispering the numbers, puzzled Mary, and so pretty soon they gave it up.

Rollo then said that he meant to try a

very short pendulum indeed, and he asked Mary to tie one up for him, not more than an inch in length. She, however, said that it would not be necessary to tie it to the branch; but, instead of that, she took hold of the string of one of the pebbles which was already hanging before them, about an inch above the pebble itself, and then set the pebble in motion; and they were both very much interested in observing how quick it vibrated to and fro.

Rollo then wanted to try a very long one, and proposed that he should climb up into the tree, and tie the end of the string to a high branch. But Mary was afraid that he would fall; and besides, she said that the pendulum would not swing clear of the branches below. She, however, immediately thought of the chamber window, and said that she would try it there. She accordingly went up into her chamber, taking a large pebble stone with her, and Rollo remained below to set the pendulum in motion, when it should be ready. Mary soon appeared at the window, and Rollo watched her while she tied her pebble to the end of a thread.

“Have you got your thread long enough?”

said Rollo. "It will take a good long thread to reach away down here."

"It is a whole spool of cotton," said Mary. And, so saying, she held up in her hand the spool, to the thread of which she was tying her pebble stone.

When it was secured, she slowly let it down, until it reached Rollo's hand, which was held up from below, ready to receive it. Mary then held the thread steady above, at a little distance out from the window, while Rollo took the stone along the side of the house, three or four feet from the place where it would naturally hang. He then let it go, and it swung back very slowly.

"O, how slow!" said Rollo.

"Yes," said Mary, "it is very slow, indeed."

"I wish you had gone up to the garret window," said Rollo.

"O, this will do very well," said Mary.

Rollo determined to see how many he could count while the stone made one oscillation to and fro. He counted sixteen.

Mary then said she was tired of experimenting, and so she should not come down again. She, however, asked Rollo to set

the pendulum swinging, and that then she would draw the thread in, and he could see that it would go faster and faster, the farther she drew it up, for that would make the string grow shorter and shorter.

Rollo did so ; and this was the end of the experiments on oscillations.



